

BROWN BOOK - 2011



ACHARYA N.G. RANGA AGRICULTURAL UNIVERSITY
RAJENDRANAGAR, HYDERABAD- 30

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BROWN BOOK - 2011

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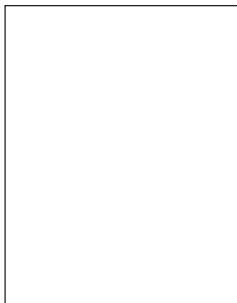
DETAILED LECTURE OUTLINES - 2011

B.Tech (Food Technology) Degree



ACHARYA N.G. RANGA AGRICULTURAL UNIVERSITY
RAJENDRANAGAR, HYDERABAD- 30

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FOREWORD

Food supplies energy for the body and building blocks for its growth and development. The advances in crop production technologies and appropriate agricultural administration interventions helped in increased food production in India in general and Andhra Pradesh in particular, making them potential producers and market players globally. Simultaneously, swelling consumerism has seen introduction of a wide range of new products like convenience foods, ready to eat snack foods, breakfast cereals, textured vegetables protein foods, value added spice based products, milk and milk based products etc. Along with new and improved food products the modernisations of food processing plants, scientific processing, greater automation, advanced research and development has provided a major impetus to this industry, which already attracts an investment of more than Rs.10,000 crore.

In addition, the food processing sector provides two fold opportunity. One in terms of developing a variety of consumer products to meet the varied demands in taste of differentiated consumer base; and secondly in utilising seasonal surplus of cereals, pulses, oilseeds, fruits, vegetables etc., which otherwise be wasted. Keeping these points in view the B.Tech Food Technology programme is offered in the university to provide good quality human resources. To make the academic programme most contemporary the old and obsolete contents are deleted and modern and classical science topics are regularly added. The BROWN BOOK - 2011 is the manifestation of this academic exercise. It contains detailed lecture outlines of all the courses offered for the degree programme. The U.G. Regulations as amended up to April, 2011 are appended to the book. I wish that this book help the students to acquire updated and relevant knowledge in food technology.

Dr. T. Yellamanda Reddy, Dean of Agriculture deserves all credit for scripting this book and completing it well before the academic year 2011-12 started. My profound appreciation to him and the team of contributors and editors who worked diligently and patiently.

(V. NAGI REDDY)

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YEAR WISE AND SEMESTER WISE DISTRIBUTION OF CREDITS AMONG DIFFERENT DEPARTMENTS

S.No.	Department	First Year		Second Year		Third Year		Credit Hours Upto III Year		Final Year	
		I	II	I	II	I	II	I	II	I	II
1	Food Science & Technology (FDST)	111 2+0	112 2+1	211 1+1 212 2+1 213 2+1 1+1	214 2+1 215 2+1 216 2+1	311 2+1 312 2+1 313 2+1 314 1+1 315 2+1 316 1+1 317 1+1 318 2+1		20	22	FTHT 400 + 0+25	FTIT 401++ 0+25
2	Food Engineering (FDEN)	121* 2+1 122* 0+2	123 2+1 124* 1+1 125* 1+1	221* 1+1 222* 2+1	223 2+1 224 2+1	321 2+1	322 2+1 323 2+1	13	19		
3	Food Chemistry & Nutrition(FDCN)	131 2+0	132 2+1	231 2+1	232 2+1	331 1+2		8	6		
4	Food and Industrial Microbiology (FDIM)	141 2+1	142 2+1	241 2+1	242 2+1	341 2+1		9	6		
5	Food Trade & Business management (FTBM)	151 2+0		251 3+0		351 1+1	352 2+1	7	3		
6	Statistics & Computer Applications (STAM)	104** 2+1	105** 2+1	204** 1+1				5	3		
7	English (ENGL)	101** 1+1						2			
8	Agricultural Extension (AEXT)				295** 1+1				2		
9	Plant Physiology (BIRM)		101** 1+1						2		
10	Seminar (SEMI)					300 0+1		1			
11	Research Project (RESP)						301 0+3		3		
12	Co-curricular activities (COCA)	100 0+1			200 0+1			1	1		
Total								66	67	25	25

* Courses to be offered by college of Agricultural Engineering, Bapatla

** Courses to be offered by Agricultural College, Bapatla.

+ Hands on training recommended on campus in various departments of college / off campus in other colleges of Food Technology in India

++ Implant Training in Food Industries in India.

DEPARTMENT WISE DISTRIBUTION OF COURSES

Course No.	Department and Title of the course	Credits
Food Science and Technology (1)		
FDST - 111	Food Production Trends and Programmes	2 (2+0)
FDST - 112	Principles of Food Preservation	3 (2+1)
FDST - 211	Post Harvest Management of Fruits & Vegetables	2 (1+1)
FDST - 212	Legume and Oil Seed Technology	3 (2+1)
FDST - 213	Food Additives	2 (1+1)
FDST - 214	Cereal Processing	3 (2+1)
FDST - 215	Fruit and Vegetable Processing	3 (2+1)
FDST - 216	Bakery and confectionery Products	3 (2+1)
FDST - 311	Processing of Milk and Milk Products	3 (2+1)
FDST - 312	Processing of Meat and Poultry Products	3 (2+1)
FDST - 313	Processing of Spices and Plantation Crops	3 (2+1)
FDST - 314	Product Development and Formulation	2 (1+1)
FDST - 315	Processing of Fish and Marine Products	3 (2+1)
FDST - 316	Extrusion Technology	2 (1+1)
FDST - 317	Food Industry By-products	2 (1+1)
FDST - 318	Food Quality and Certification	3 (2+1)
Total		42 (27+15)
Food Engineering (2)		
FDEN - 121	Principles of General Engineering	3 (2+1)
FDEN - 122	Engineering Drawing	2 (0+2)
FDEN - 123	Energy Generation & Conservation	3 (2+1)
FDEN - 124	Workshop Practice	2 (1+1)
FDEN - 125	Fluid Mechanics & Hydraulics	2 (1+1)
FDEN - 221	Heat & Mass Transfer	2 (1+1)
FDEN - 222	Refrigeration Engineering & Cold Chain	3 (2+1)
FDEN - 223	Food Processing Equipment – I	3 (2+1)
FDEN - 224	Food Packaging	3 (2+1)
FDEN - 321	Instrumentation & Process Control	3 (2+1)
FDEN - 322	Food Processing Equipment – II	3 (2+1)
FDEN - 323	Food Plant Design & Layout	3 (2+1)
Total		32 (19+13)

Food Chemistry and Nutrition (3)		
FDCN - 131	Human Nutrition	2 (2+0)
FDCN - 132	Biochemistry	3 (2+1)
FDCN - 231	Food Chemistry of Macro-Nutrients	3 (2+1)
FDCN - 232	Food Chemistry of Micro-Nutrients	3 (2+1)
FDCN - 331	Techniques in Food Analysis	3 (1+2)
Total		14 (9+5)
Food and Industrial Microbiology (4)		
FDIM - 141	Fundamentals of Microbiology	3 (2+1)
FDIM - 142	Food Microbiology	3 (2+1)
FDIM - 241	Fermentation and Industrial Microbiology	3 (2+1)
FDIM - 242	Food Safety and Microbial Standards	3 (2+1)
FDIM - 341	Food Biotechnology	3 (2+1)
Total		15 (10+5)
Food Trade and Business Management (5)		
FTBM - 151	Principles of Economics	2 (2+0)
FTBM - 251	Business Management & International Trade	3 (3+0)
FTBM - 351	IT Application in Food Industry	2 (1+1)
FTBM - 352	Food Laws & Regulations	3 (2+1)
Total		10 (8+2)
Courses offered by other Departments		
English		
ENGL - 101	Comprehension and Development of Communication Skills	2 (1+1)
Statistics and Computer Application		
STAM - 104	Engineering Mathematics	3 (2+1)
STAM - 105	Statistics	3 (2+1)
STAM - 204	Introduction to Computer Application	2 (1+1)
Total		8 (5+3)
Plant Physiology		
BIRM - 101	Environmental Sciences	2 (1+1)
Agricultural Extension		
AEXT - 295	Entrepreneurship Development	2 (1+1)
FTHT - 400	Experiential Learning Programme / Hands on Training	25(0+25)
FTIT - 401	In-plant Training	25(0+25)
Non-credited Courses of Co-curricular Activities		
COCA - 100	Physical Education	1 (0+1)
COCA - 200	NSS	1 (0+1)

YEAR WISE AND SEMESTER WISE DISTRIBUTION OF COURSES

I YEAR I SEMESTER

S.No.	Course No.	Title	Credits
1	FDST 111	Food Production Trends and Programmes	2 (2+0)
2	FDEN 121	Principles of General Engineering*	3 (2+1)
3	FDEN 122	Engineering Drawing*	2 (0+2)
4	FDCN 131	Human Nutrition	2 (2+0)
5	FDIM 141	Fundamentals of Microbiology	3 (2+1)
6	FTBM 151	Principles of Economics	2 (2+0)
7	STAM 104	Engineering Mathematics**	3 (2+1)
8	ENGL 101	Comprehension & Development of Communication Skills**	2 (1+1)
9	COCA 100	Physical Education	1 (0+1)
Total			20 (13+7)

I YEAR II SEMESTER

S.No.	Course No.	Title	Credits
1	FDST 112	Principles of Food Preservation	3 (2+1)
2	FDEN 123	Energy Generation and Conservation	3 (2+1)
3	FDEN 124	Workshop Practice*	2 (1+1)
4	FDEN 125	Fluid Mechanics & Hydraulics*	2 (1+1)
5	FDCN 132	Biochemistry	3 (2+1)
6	FDIM 142	Food Microbiology	3 (2+1)
7	STAM 105	Statistics**	3 (2+1)
8	BIRM 101	Environmental Science**	2 (1+1)
Total			21 (13+8)

II YEAR I SEMESTER

S.No.	Course No.	Title	Credits
1	FDST - 211	Post Harvest Management of Fruits and Vegetables	2 (1+1)
2	FDST - 212	Legume and Oil Seed Technology	3 (2+1)
3	FDST - 213	Food Additives	2 (1+1)
4	FDEN - 221	Heat and Mass Transfer*	2 (1+1)
5	FDEN - 222	Refrigeration Engineering and Cold chain*	3 (2+1)
6	FDCN - 231	Food Chemistry of Macro Nutrients	3 (2+1)
7	FDIM - 241	Fermentation and Industrial Microbiology	3 (2+1)
8	FTBM - 251	Business Management and International Trade	3 (3+0)
9	STAM - 204	Introduction to computer Applications**	2 (1+1)
Total			23 (15+8)

II YEAR II SEMESTER

S.No.	Course No.	Title	Credits
1	FDST - 214	Cereal Processing	3 (2+1)
2	FDST - 215	Fruit and Vegetable Processing	3 (2+1)
3	FDST - 216	Bakery and Confectionery Products	3 (2+1)
4	FDEN - 223	Food Processing Equipment - I	3 (2+1)
5	FDEN - 224	Food Packaging	3 (2+1)
6	FDCN - 232	Food Chemistry of Micronutrients	3 (2+1)
7	FDIM - 242	Food Safety and Microbial Standards	3 (2+1)
8	AEXT - 295	Entrepreneurship Development**	2 (1+1)
9	COCA - 200	NSS	1 (0+1)
Total			24 (15+9)

III YEAR I SEMESTER

S.No.	Course No.	Title	Credits
1	FDST - 311	Processing of Milk & Milk Products	3 (2+1)
2	FDST - 312	Processing of Meat & Poultry Products	3 (2+1)
3	FDST - 313	Processing of Spices & Plantation Crops	3 (2+1)
4	FDST - 314	Product Development & Formulation	2 (1+1)
5	FDEN - 321	Instrumentation & Process Control	3 (2+1)
6	FDCN - 331	Techniques in Food Analysis	3 (1+2)
7	FDIM - 341	Food Biotechnology	3 (2+1)
8	FTBM - 351	IT Applications in Food Industry	2 (1+1)
9	SEMI - 300	Seminar+	1 (0+1)
Total			23 (13+10)

III YEAR II SEMESTER

S.No.	Course No.	Title	Credits
1	FDST - 315	Processing of Fish & Marine Products	3 (2+1)
2	FDST - 316	Extrusion Technology	2 (1+1)
3	FDST - 317	Food Industry By-products	2 (1+1)
4	FDST - 318	Food Quality & Certification	3 (2+1)
5	FDEN - 322	Food Processing Equipment - II	3 (2+1)
6	FDEN - 323	Food Plant Design & Layout	3 (2+1)
7	FTBM - 352	Food Laws & Regulations	3 (2+1)
8	RESP - 301	Research Project++	3 (0+3)
Total			22 (12+10)

* Courses to be offered by College of Agricultural Engineering, Bapatla.

** Courses to be offered by Agricultural College, Bapatla.

+ Course to be offered by Department of Food Trade & Business Management

++ Course to be offered by different Departments of the college

IV YEAR I SEMESTER

S.No.	Course No.	Title	Credits
1	FTHT - 400	Experiential Learning Programme/Hands on Training	25

IV YEAR II SEMESTER

S.No.	Course No.	Title	Credits
1	FTIT - 401	In-Plant Training	25

DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY

1. Course No. : FDST - 111
2. Title : **Food Production Trends and Programmes**
3. Credit hours : 2(2+0)
4. General Objective : To impart knowledge to the students about advanced technology in food science and recent trends adapted in food science and technology

5. Specific Objectives

a) Theory

By the end of the course, the students will be able to

- i. know about terminology regarding food technology and various research stations of agriculture located in different places and their importance in agriculture
- ii. learn about different technological processes of food industry, classification of foods according to market, food crops and its Post Harvest Technology, World Food Day, growth of Indian Food processing industry, recent technologies of food technology and their principles and applications

b) Practical

No practical component

A. Theory Lecture Outlines

1. Introduction - Food Science and Technology
2. Definition - Food science, Food technology and their sub discipline, difference between Food Science and Technology
3. Status of food processing industry in India and abroad
4. Reasons for slow growth of Indian food industry- scope for expansion of market - Dairy, Bakery, Confectionary, Beverages and Snack foods etc.
5. Potential and prospects of Indian food Industry
6. Popularity of Indian foods- National and International Projects/Institute and their food products
7. Magnitude and Interdependent activities and processing agencies
8. Ministry of Food Processing - Objectives and its function to develop the food processing industry. APEDA - Agricultural Processed Food Products Export Development Authority

9. Food characteristics - Food nutrients-Proteins, Fats, Carbohydrates, Vitamins and Minerals
- Functions - Sources
10. Classification of foods based on pH - Low acid food, medium acid food, highly acid food and acid food - Definition and Examples
11. Types of foods - Convenience food, definition, characteristics and classification - Ready-to-Eat foods, Ready-to-use-foods and beverages
12. The point to be kept in mind while purchasing convenience foods - Advantages and disadvantages of convenience foods - flow chart for some ready to eat products
13. New food product development - Strategies for new product development - Recent trends for processing of food, its principle and application, new techniques for new food product development - Genetically modified foods - Advantages and disadvantages
14. Functional foods - formulated foods - Special foods - Imitated meat food / meat imitations - meat food - definitions - Advantages and disadvantages
15. Food demand and supply - food requirements - factors affecting on food demands - present market segments of food process industry in India
16. Features of food processing industry to meet the needs - processed food industry in India - further priorities in food production need
17. Food losses and factors affecting food losses - physical, chemical, physiological and biological factors
18. Programmes and strategies to eliminate the food losses - Post harvest management, Importance of value addition and methods of storages
19. Packaging of processed food - Definition for modified atmospheric packaging - Vacuum packaging – Aseptic packaging for improving the shelf life of perishable foods.
20. Different types of losses - priorities - Scope of value addition in fruit and vegetables
21. Food availability area and production of fruits, vegetables, spices, rice, wheat, milk etc - Nutrient management
22. Development of disease resistant varieties - Organic farming for improvement of the food Production
23. Classification of crops - Average area, production, nutritional composition, cereals and millets, pulse based food crops
24. Classification of food crops - Oil seeds, Fibre crops, sugar crops and their nutritional Composition
25. Year wise production trends, comparison of food grains and future need

26. Production and estimated post harvest losses - Development programmes, Research organization - Potential of income and employment generation through post harvest operation
27. Programmes for food production - programme implementation - Brown revolution - Yellow revolution - Blue revolution - Production increase for growing population in India
28. Programmes for food production - food security - factors affecting on food security - Green revolution - White revolution
29. Globalization of food Industries, food standards to meet global market - global demands for Food
30. World Food Day - Importance for theme - Agricultural growth and plan for elimination of Hunger
31. Present trends of consumption - further requirement - consumer change of aptitude in food product consumption
32. National and International trends in food handling, processing and marketing

B. Practical class outlines

No practical component

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DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY

1. Course No. : FDST - 112
2. Title : **Principles of Food Preservation**
3. Credit hours : 3 (2+1)
4. General Objectives : To impart the basic knowledge of different principles involved in food preservation and processing to the under graduate students
5. Specific Objectives
 - a) Theory

By the end of the course, the students will have

- i. awareness about different concepts involved in food spoilage and its prevention by using different food preservation principles and technologies.

- b) Practical

By the end of the course, the students will

- i. learn and practice different methods of food preservation.

A) Theory Lecture Outlines

1. Scope - Principles of Food Science and Technology - Introduction - Definitions of Food, Food Science and Technology - introduction to other relevant terms pertaining to food technology
2. Food Classification - Basic four, Basic five (ICMR), Basic seven - Perishables - Semi perishables and Non perishables
3. Food Spoilage-types- factors affecting spoilage - Definition of Food Spoilage - Major types of food spoilage including micro biological - Bio-chemical, physical and enzymatic spoilage (Bio-chemical spoilage)
4. Spoilage by insects, parasites and rodents - Mechanical spoilage (Physical spoilage) - Chemical spoilage
5. Factors affecting food spoilage - Extrinsic: Temperature- RH- O₂, CO₂; Intrinsic - pH - Moisture content- a_w
6. Chemical nature - oxidation reduction potential - physical structure - available nutrients - presence of anti microbial agents
7. General Principles of Food Preservation - Physical Methods - Chemical Methods - Fermentation - Other Methods

8. Traditional methods of storage and preservation - Grain storage structures - Puri - Kotlu - Gade / Gumi - Jadi / Kunda - Pathara - Basta / Sanchi
9. Different processing methods of food - Objectives of Cooking - Cooking methods - Moist heat - dry heat and combination method
10. Boiling - Simmering - Poaching - Stewing - Blanching - Steaming - Microwave cooking- Baking
11. Preservation by salt -Types of salts used- uses of salt-Brine - preparation of brines - Composition of Brines used in canning-pickling-advantages-disadvantages
12. Preservation by sugar - preparation of syrups for canning - measuring strength of syrups- Pearson square method
13. Preservation by Thermal Processing - Blanching - Pasteurization-types-equipment - Sterilization
14. Preservation by canning - different unit operations involved in canning-equipment used in canning- types of canning containers
15. Use of low temperatures - Types of cold preservation - Chill storage - Procedure of low Temperature storage - types of freezing equipment used
16. Various changes occurring during freezing and thawing - methods of food freezing - Quick fast freezing and slow freezing-factors affecting storage
17. Drying / Dehydration - Definition of drying - Advantages of dried foods - Sun drying - Mechanical dehydration - Direct heated driers - Indirect heated driers - Cabinet driers - Tunnel drier - Drum Drier - Fluidized Bed Drier - Spray Drier
18. Factors affecting dehydration of food-Dehydration - methods of dehydration-advantages disadvantages of dehydration
19. Changes in constituents of Food materials - Shrinkage, case hardening - Thermo plasticities - Reconstitution properties - Thin layer drying – Deep Bed Drying
20. Moisture Content expression - Types of moisture definition - Bound moisture - Unbound moisture - Free moisture
21. Preservation by concentration - What is concentration - Methods of concentration - Film evaporators - Falling evaporators
22. Flash Evaporator - Freeze Concentration - Ultra Filtration and reverse osmosis
23. Preservation by radiation - Food irradiation - What is food irradiation - Forms of energy - Ionizing radiation and sources - Units of radiation - Effects of radiation

24. Irradiation doses for treating foods - Mechanism underlying Irradiation-Advantages-Disadvantages
25. Preservation by Chemicals - Introduction - Class I Preservatives - Class II Preservatives - Safe limits of usage
26. Preservation by mould inhibitors, antibiotics, acidulants - Antioxidants - Antibiotics - Mould inhibitors - Parabens - Epoxides - Benzoic acid - Propionic Acid
27. Preservation by fermentation - Definition - Some industrial fermentation in food industries
28. Recent methods in preservation : Pulsed electric field processing - principle - equipment - Mechanism - effect on quality - advantages - disadvantages
29. High pressure processing - principle - equipment - Mechanism - effect on quality - advantages - disadvantages
30. Processing using ultrasound - Principle - equipment - mechanism - effect on food quality
31. Dielectric and Ohmic heating - Principle - equipment - mechanism - effect on food quality
32. Infrared heating - Theory - equipments - effect on food quality

B) Practical Class Outlines

1. Introduction to different equipments, accessories in food science & technology laboratory
2. Survey on availability of different varieties of processed foods ,raw materials, cost and technology used
3. Study of storage structures
4. A visit to the nearby warehouse
5. Different processing methods used in food preparation & changes in food
6. Preservation of foods using high concentration of sugar
7. Preservation of food using Salt
8. Preservation of food using Acid.
9. Preservation of foods by different drying /dehydration methods and reconstitution of foods by dehydration methods.
10. Methods of processing of foods using different temperatures-Dry heat methods
11. Methods of processing of foods using different temperatures-moist methods
12. Preservation of foods by freezing

13. Preservation of foods by fermentation
14. Preservation of foods by irradiation & ionizing radiation
15. Storage stability testing of processed foods
16. Visit to different food processing industries

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DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY

1. Course No. : FDST - 211
2. Title : **Post Harvest Management of Fruits and Vegetables**
3. Credit hours : 2(1+1)
4. General Objectives : To impart knowledge to the students on the concepts of post harvest management practices and value addition in fruits and vegetables
5. Specific Objectives

a) Theory

By the end of the course, the students will be able to

- i. know about the post harvest losses and it's management
- ii. know about maturity indices & harvesting indices of different fruits and vegetables

b) Practical

By the end of the practical exercises, the students will be able to

- i. know about different storage methods of fruits and vegetables
- ii. know about different practices used in post harvest management of fruits & vegetables

A) Theory Lecture Outlines

1. Definition of fruits and vegetables - classification of fruits and vegetables based on derived plant tissue and botanical classification
2. Post harvest technology - Introduction and Definition of Post harvest technology, over view of concept and science. Significance of Post harvest technology in loss reduction, in export, economy, and employment generation
3. Structure and composition of fruits and vegetables - Chemical composition and Nutritive value – Water, Carbohydrates, Protein, Lipids, organic acids, vitamins and minerals, volatiles
Physical textural characteristics of fruits and vegetables
4. Physiology and biochemistry of fruit and vegetables - physiological development - Fruit ripening. physiology of respiration - Classification of fruits and vegetables based on respiratory pattern- Climacteric fruits - Non climacteric fruits - examples - Differences - Effect of ethylene - Role of ethylene in climacteric and non-climacteric fruits
5. Biochemistry of Respiration - Aerobic metabolism - EMP sequence - TCA cycle – Respiration quotient - Anaerobic metabolism

6. Fruit Maturity - Definition, methods of maturity determination, maturity indices for selected fruits and vegetables. Chemical changes during maturation - Fruit color, Carbohydrate content, organic acids, Aroma
7. Effect of temperature on Sugar - Starch balance, Storage life of produce and Methods of cooling - Room cooling, Forced air cooling, Hydro cooling, Contact icing, vacuum cooling, Evaporative cooling
8. Effect of water loss and humidity - Factors affecting water loss - Surface area/volume ratio - Nature of surface coatings, Mechanical damage to tissue - Control of water loss - Air movement - Packaging
9. Storage atmosphere - CO₂ and O₂, Metabolic effects, Effect on microbial growth, Ethylene - Methods for modifying CO₂ and O₂ concentrations - Atmosphere control by addition of N₂ and CO₂, storage in plastic films, methods of controlling fruit ripening
10. Storage methods; controlled atmospheric storage, bead atmospheric storage, hypobaric storage, zero energy cool chambers
11. Physiological disorders - Low temperature disorders - Chilling injury - Physiological disorders - mineral deficiency disorders
12. Maturity- Determination of maturity - Determination of commercial maturity - Quality evaluation of fruits and vegetables- Quality standards- Post Harvest factors influencing quality
13. Harvesting of important fruits and vegetables - Pathology - Control of Post harvest Wastage - Post harvest handling systems adopted for citrus and apple fruits
14. Commodity treatments - Controlled ripening, Controlled degreening, Control of superficial scald in Apple - Calcium application to apple, Increasing water loss from Apple, Waxing, Plant growth regulators, Sprout inhibitors - Disinfestation.
15. Handling, Packaging and distribution - Effect of packaging on produce quality - Packing and Storage
16. Technology of storage - Methods of storage- In ground storage, Air cooled storage - Ice refrigeration - Mechanical refrigeration

B) Practical Class Outlines

1. Studies on morphological features of some selected fruits and vegetables
2. Studies of maturity indices - I
3. Studies of maturity indices - II
4. Studies on harvesting of fruits and vegetables

5. Determination of RQ
6. Studies on export of pre cooling & storage of fruits & vegetables
7. Studies on wax coating on apples
8. Studies on wax coating on papaya
9. Studies on wax coating on citrus, mango, amla
10. Studies on use of chemicals for ripening of banana, mango, papaya
11. Studies on various storage systems & structures
12. Studies on prepackaging of fruits
13. Studies on prepackaging of vegetables
14. Studies on physiological disorders- chilling injury of banana & custard apple
15. Visit to commercial packaging house
16. Visit to commercial storage structures

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DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY

1. Course No. : FDST - 212
2. Title : **Legume and Oil Seed Technology**
3. Credit hours : 3(2+1)
4. General Objective : To impart knowledge to the students on Legume and Oil Seed processing and to develop good expertise on the technical aspects of dhal milling, oil milling and various legumes and oil seeds based product preparations.

5. Specific Objectives

a) Theory

By the end of the course, the students will be able to

- i. know about different pulses processing aspects and preparation of products with pulses
- ii. learn about different oil seeds, oil milling by expellers, solvent extraction of oils, refining of oils and utilization of oil seed meals for different food uses.

b) Practical

By the end of the practical exercises, the students will be able to

- i. Develop skills on dhal milling aspects of different legumes
- ii. Determine the physical properties of legumes and oil seeds
- iii. Learn about the oil milling by expellers and by solvent extraction

A) Theory Lecture Outlines

1. Present status and future prospects of legumes - Current trends in area, production and yield - Technology Mission on Oil seeds and Pulses (TMOP)
2. Morphological description of pulses
3. Classification and types of legumes - Chemical composition and nutritional Value
4. Anti-nutritional factors in pulses and their chemistry - Methods of removal of anti-nutritional factors

5. Processing of legumes - Milling, Soaking, Germination, Fermentation, Roasting and Parching, Extrusion, Parboiling and Agglomeration.
6. Physical and chemical changes during the processing of legumes
7. Dehulling of pulses - Advantages - Methods of dehulling - Traditional and modern methods of dehulling
8. Dehulling pretreatments - wet treatment, soaking, chemical treatment, dry treatment, oil treatment and heat treatment
9. Seed characteristics that affect dehulling - Nature of seed coat and physical characteristics of grains
10. Storage of pulses - Insect control measures in pulses
11. Milling of pulses - Wet milling and dry milling - Commercial milling of pulses by traditional methods
12. Dry milling of Tur, Black gram, Bengal gram, Lentil, Peas and Green gram
13. Wet milling of Tur - Modern CFTRI method of pulse milling
14. Dhal milling equipments and effect on quality - Principal products
15. Fermented products of legumes - Idli, Dosa, Soya curd(Tofu), Textured Vegetable Protein (TVP), Soya sauce, Tempeh, Natto and Miso
16. Cooking quality of dhal - Factors affecting cooking quality of dhal and Legumes - Processed legume products - Puffed chick pea and Peas, Canned dry pea
17. Quick cooking dhal and instant dhal - Uses of pulses - Role of pulses in cookery - Medicinal value of pulses
18. Present status and future prospects of oil seeds - Annual oil crops, Perennial oil seed plants and Minor oil seeds - Chemical composition and characteristics of oil seeds and oils
19. Anti-nutritional factors in oil seeds - Elimination methods
20. Post Harvest Technology of oil seeds - Handling- Drying and Storage - Grading - Pre-treatments - Cleaning - Dehulling - Size reduction - Flaking - Heat treatment
21. Oil extraction - Rendering - Traditional methods - Ghani - Power ghanis - Hydraulic Press - Expellers - Principle and structural design of expeller
22. Solvent extraction process - Principle - Pretreatment - Breaking - Cracking - Flaking - Extraction principles - Factors affecting the extraction process - Desolventisation
23. Processing of oil seeds - Production and refining of cotton seed oil - Mechanical expression of cotton seed oil - Refining of crude cotton seed oil

24. Solvent extraction of soya bean oil - Sunflower oil - Palm oil - Coconut oil
25. Utilization of rice bran - Stabilization of rice bran - Dry heat treatment - Wet heat treatment
26. Extraction of rice bran oil - Solvent extraction - batch and continuous methods
27. Refining of oils - Degumming - Neutralization - Bleaching - Filtration – Deodourization - Winterization - Principles and process controls
28. Refining of crude bran oil into edible oil - Uses of bran and bran oil
29. Hydrogenation - Products based on hydrogenated fats -Margarine - Shortenings - Salad oils - Vanaspati - Salad dressings - Rancidity in fats and oils - Types of rancidity - Tests for rancidity
30. New technologies in oil seed processing
31. Utilization of oil seed meals for different food uses
32. High protein products - Protein concentrates - Protein isolates

B) Practical Class Outlines

1. Determination of physical properties of legumes
2. Determination of physical properties of oil seeds
3. Determination of moisture content of legumes and oil seeds
4. Study of mini dhal mill
5. Study of effect of pretreatments on dhal milling
6. Application of oil and red earth slurry on dhal milling process
7. Soaking studies on dhal milling
8. Study of sprouting of legumes
9. Study of cooking quality of dhal
10. Visit to a commercial dhal mill
11. Study of baby oil expeller
12. Study of effect of pretreatments to oil seeds on oil recovery - I
13. Study of effect of pretreatments to oil seeds on oil recovery - II
14. Determination of oil expelling efficiency from different oil seeds
15. Determination of oil content of an oil seed
16. Visit to a commercial oil extraction unit

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DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY

1. Course No. : FDST - 213
2. Title : **Food Additives**
3. Credit hours : 2(1+1)
4. General Objectives : To create awareness in students regarding different types of food additives & their role in food processing
5. Specific Objectives
 - a) Theory

By the end of the course, the students will be able to

- i. learn different aspects of Food Additives - Permitted & Non-permitted Additives, their safety aspects & regulations along with recommended intakes

b) Practical

By the end of the course, the students will

- i. learn Identification, determination to both qualitative & quantitative procedures for estimation of different Food Additives in food

A) Theory Lecture Outlines

1. Introduction: What are Food Additives? - Role of Food Additives in Food Processing - functions - Classification - Intentional & Unintentional Food Additives
2. Toxicology and Safety Evaluation of Food Additives - Beneficial effects of Food Additives / Toxic Effects - Food Additives generally recognized as safe (GRAS) - Tolerance levels & Toxic levels in Foods - LD₅₀ Values of Food additives
3. Naturally occurring Food Additives - Classification - Role in Food Processing - Health Implications.
4. Food colors - What are food colors - Natural Food Colors - Synthetic food colors - types - their chemical nature - their impact on health.
5. Preservatives - What are preservatives - natural preservation- chemical preservatives - their chemical action on foods and human system
6. Anti-oxidants & chelating agents - what are anti oxidants - their role in foods - types of anti-oxidants - natural & synthetic - examples - what are chelating agents - their mode of action in foods - examples.

7. Surface active agents - What are surface active agents - their mode of action in foods - examples.
8. Stabilizers & thickeners - examples - their role in food processing.
9. Bleaching & maturing agents: what is bleaching - Examples of bleaching agents - what is maturing - examples of maturing agents - their role in food processing.
10. Starch modifiers: what are starch modifiers - chemical nature - their role in food processing.
11. Buffers - Acids & Alkalis - examples - types - their role in food processing
12. Sweeteners - what are artificial sweeteners & non nutritive sweeteners - special dietary supplements & their health implication - role in food processing.
13. Flavoring agents - natural flavors & synthetic flavors - examples & their chemical nature - role of flavoring agents in food processing.
14. Anti-caking agents - their role in food processing
15. Humectants - definition on their role in food processing.
16. Clarifying agents - definition examples - their role in food processing.

Practical Class Outlines

1. Estimation of chemical preservatives by TLC (organic)
2. Estimation of chemical preservatives by TLC (inorganic)
3. Identification of food colours by TLC (Permitted)
4. Identification of food colours by TLC (Non-permitted)
5. Estimation of chlorophyll.
6. Quantitative estimation of added dyes in foods (permitted)
7. Quantitative estimation of added dyes in foods (non permitted)
8. Estimation of Antioxidants in foods (BHA, BHT)
9. Estimation of Antioxidants in foods (Propylgallates)
10. Determination of phenolic content in foods
11. Determination of lycopene content in foods
12. Quantitative estimation of dyes
13. Quantitative estimation of dyes

14. Determination of vegetable colours.
15. Determination of chemical preservatives and Synthetic sweetening agents
16. Extraction of gum from fruit & vegetable products

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DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY

1. Course No. : FDST - 214
2. Title : **Cereal Processing**
3. Credit hours : 3 (2+1)
4. General Objective : To impart knowledge to the students on cereal and millet processing, traditional and improved methods of cereal processing and to develop good expertise on the technical aspects of preparation of cereal and millet based products
5. Specific Objectives :
 - a) Theory

By the end of the course, the students will be able to

- i. know about different cereals and millets and their processing aspects
- ii. acquaint with knowledge on utilization of by-products from cereals, preparation of ready to eat breakfast cereals and instant cereal foods

b) Practical

By the end of the practical exercises, the students will be able to

- i. Develop skills on cereal processing aspects
- ii. Determine the physical properties of cereals and millets
- iii. Learn about preparation of ready to eat cereal products

A) Theory Lecture Outlines

1. Present status and future prospects of cereals and millets - Current trends in area, production and yield
2. Structure of cereals - Wheat, Corn, Rice, Barley, Oat, Rye and Sorghum
3. Composition and nutritive value of cereals. Physico - chemical properties of cereals, major and minor millets - Bulk density, True density, Porosity, Sphericity, Roundness, 1000 grain weight, Coefficient of friction and Angle of repose
4. Thermal properties - Specific heat - Thermal Conductivity - Thermal diffusivity
5. Theory of grain drying - Thin layer drying - Moisture content - Moisture measurement - Direct and indirect methods

6. Equilibrium moisture content (EMC) - Determination of EMC - EMC models - Hysteresis - Bound, unbound and free moisture
7. Drying curves - Constant rate period and falling rate period - Deep bed drying - Problems on moisture content
8. Methods of grain drying - Conduction, Convection, Radiation, Dielectric, Chemical and Sack drying
9. Grain dryers - Unheated and heated air dryers - Batch and continuous type - Flat bed type - PHTC type - Columnar type - LSU type - Baffle type - Rotary type
10. Paddy and its handling - Cleaning - Drying - Cracking of paddy during drying and its prevention - Methods of paddy drying - Sun drying and mechanical drying
11. Rice milling - Traditional rice milling machinery - Engelberg huller, Huller mill, Battery of hullers, Sheller cum huller mill, Sheller mill, Sheller cum cone polisher mill
12. Modern rice milling process - Cleaning, Dehusking, Husk separation, Paddy separation, Polishing and Grading operations and their related equipments
13. Advantages and disadvantages of milling machineries - Factors that affect rice out turn during milling
14. By-products of rice milling - Rice bran, rice hulls, broken grains, rice pollards
15. Parboiling of paddy and its principle - Physico-chemical changes during parboiling - Steps in parboiling - soaking, steaming and drying
16. Effect of parboiling on milling, nutritional and cooking quality of rice.
17. Advantages and disadvantages of parboiling
18. Methods of parboiling of paddy - Traditional methods- Atapa, Balam, Josh, Sela and Siddha processes
19. Parboiling - single boiling and double boiling methods - Improved methods - CFTRI method - Schule process - Crystal rice process
20. Rice conversion process - Jadavpur University method - Malek process - Rice Growers Association of California process - Avorio process
21. Fernandes process - IRRRI process - True continuous parboiling process - RPEC method
22. Sodium chromate method - Brine solution method - Kisan continuous parboiling method - Pressure parboiling method
23. Ageing of rice - Enrichment of rice
24. Rice fortification - Methods of rice fortification

25. Processed products from rice - Rice flour - Parched rice - Puffed rice - Flaked rice - Rice starch - Instant rice - Canned rice
26. Wheat - Types of wheat - Wheat quality and grading
27. Wheat flour milling - Components of a wheat mill
28. Corn dry milling and wet milling - Products of corn milling
29. Milling of Barley, Oats and Rye
30. Milling of Sorghum, Bajra, Ragi - Their food uses
31. Malting of cereals - Uses of malt
32. Breakfast cereal foods - Flaked breakfast cereals, puffed breakfast cereals, shredded and granular breakfast cereals and cereals puffed by extrusion

B) Practical Class Outlines

1. Study of morphological characteristics of cereals - I
2. Study of morphological characteristics of cereals - II
3. Determination of physical properties of cereals - I
4. Determination of physical properties of cereals - II
5. Determination of colour of cereals
6. Determination of moisture content of cereals
7. Experiment on parboiling of paddy
8. Cooking quality studies of rice
9. Experiments on rice shelling
10. Experiments on rice polishing
11. Processing of pop corn
12. Processing of puffed rice
13. Processing of flaked rice
14. Processing of cereal and millet malts
15. Visit to rice bran oil extraction industry
16. Visit to a commercial cereal processing unit

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DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY

1. Course No. : FDST - 215
2. Title : **Fruit and Vegetable Processing**
3. Credit hours : 3 (2+1)
4. General Objectives : To train the students in the field of Fruit and Vegetable Processing
To enable the students learn different preservation techniques to curb post-harvest losses in the field of agriculture

5. Specific Objectives

a) Theory

By the end of the course, the students will be able to

- i. learn processing of fruits & vegetables - different preservation techniques to improve the shelf life of seasonal fruits.

b) Practical

By the end of the course, the students will know the

- i. processing of fruit & Vegetable products like Jams, Jellies, Squashes.

A) Theory Lecture Outlines

1. Production and processing scenario of Fruits and vegetables in India and world-scope of fruit and vegetable processing industry in India - present status, constraints and prospective.
2. Overview of Principles of preservation - Drying /dehydration - process - types - pretreatments required - factors affecting rate of dehydration - Reconstitution - coefficient of rehydration
3. Freezing - process - types of freezing-changes during cold storage - thawing; Canning of fruits and vegetables - process - unit operations
4. Concentration - types of concentration - changes during concentration
5. Chemical preservation - different types of chemicals used in processing of fruits and vegetables - Preservation by Sulphur dioxide and Sodium benzoate- safe limits of usage
6. Hurdle concept - Intermediate moisture foods
7. Irradiation - process - principle and application in fruit and vegetable Industry - safe doses of usage
8. Processing Technology of Jam - What is Jam? - Ingredients and their role in quality of Jam - Processing of Jam(flowcharts) - Tests for end point determination-Problems in Jam making

9. Pectin - properties - theories - Olsen's theory, Spencer's theory, Hinton's theory, Fibril theory
10. Jelly and Marmalades - Jelly - Difference between Jam and Jelly - Processing of Jelly - End point determination - Failure of Jellies to set- Cloudy or foggy Jellies - Formation of crystals - Syneresis
11. Marmalades - What is a marmalade? - types - Jam marmalade - Jelly marmalade - Problems in marmalade making
12. Fruit preserves and candied fruits - What are fruit preserves? - Preparation of fruits preserves - problems in making; Candied fruits - Preparation of candied fruits; Glazed fruit - preparation
13. Glazed fruit - preparation, Crystallized fruit - preparation-problems in preparation of preserves and candied fruit
14. Chutneys - Preparation of chutney; Pickles - Types of Pickling-Pickling with salt - Dry salting - Brining
15. Pickling with Vinegar and fermentation - Saurkraut - Role of lactic acid bacteria in pickling; Pickling with oil - pickling with mixture of salt, oil and spices - Problems/ spoilage in pickles
16. Sauces and Ketchups - What are sauces? - Difference between sauce and a ketchup - classification of sauces-thick and thin sauces-processing of Tomato sauce/ketchup - Preparation of soya sauce(thin sauce) - problems in making of sauces
17. Processing Technology of Fruit Beverage - Unit operations involved in preparation of fruit beverage
18. Equipment used in the preparation of beverages - pulping - Screw type juice extractors - Burring machines-rollers-Taglith press by CFTRI
19. Basket press - Rack and cloth press-Hydraulic press - Deaerators - Sietz filters - Flash pasteurizers
20. Types of Beverages - Processing technology of Beverages - Flow charts of Juice - examples - RTS - Nectar
21. Processing of Beverages like Cordial, Squash, Crush - FPO Specification - Processing method - Ingredients - Flow Charts.
22. Processing of Syrups - natural and synthetic- rose syrup -almond syrup- fruit syrup.
23. Fruit juice concentrate - Fruit juice powder - Lemon Barley water - Carbonated beverages

24. Processing technology of Fruit Cheese - Processing of fruit cheese - guava cheese - Processing of Fruit leather - mango leather
25. Fruit toffee - preparation of banana toffee - Processing of Fruit Butter
26. Processing technology of vegetable wafers - potato wafers - preparation - types of peeling - discolorations - slicing - Drying - Frying - Salting - packing
27. Vegetable Papads - Processing of Papads - preparation - equipment used for preparation - packing
28. Processing of Soups - preparation of tomato soup-packing/canning - preparation of soup powders - technology and equipment required
29. Fermented products from fruits and vegetables - Vinegar - types of vinegar - methods of vinegar production - Quick method - Orleans slow process - Generator process - problems in vinegar production
30. Fermented fruit beverages - Wine - types of wines - equipment required - preparation - problems
31. Sparkling clear wines - Champagne and Cider; Fortified wines - Sherry, vermouths; orange wine, Perry, Tokay, Port
32. Cashew wine/ Brandy (Feni), Neera, Toddy, Arrack and different distilled spirits - their source and alcohol percentages

B) Practical Class Outlines

1. Canning of Fruits and Vegetables
2. Preparation of Jams
3. Preparation of Jelly and Marmalade
4. Preparation of Preserves, Candies and Crystallized Fruits
5. Preparation of Chutneys
6. Preparation of Pickles
7. Preparation of Sauces, Ketchups
8. Preparation of Fruit Squashes, Fruit Juices and RTS
9. Preparation of Fruit nectar, Cordial and Crush
10. Preparation of Wine and Vinegar

11. Preparation of Carbonated Beverages
12. Preparation of Fruit cheese and Toffee
13. Preparation of Wafers and Papads
14. Dehydration of Fruits and Vegetables
15. Dehydration of leafy vegetables and Soup Powders
16. Visit to Fruit and Vegetable Processing Industry

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DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY

1. Course No. : FDST - 216
2. Title : **Bakery and Confectionery Products**
3. Credit hours : 3 (2+1)
4. General Objectives
 - To train the students in Bakery & Confectionery and to impart knowledge about different raw materials used and their role.
 - To impart knowledge on different equipments, processing of different Products and their packaging & Quality maintenance.
5. Specific Objectives
 - a) Theory

By the end of the course, the students will have

- i. knowledge in the areas of Bakery and Confectionary product processing
- b) Practical

By the end of the course, the students will

- i. gain skills in the areas of bakery and confectionery products - raw materials required, equipment required and quality of the baked products

A) Theory Lecture Outlines

1. History of Bakery and Confectionery - Present Trends - Prospects - Nutrition facts of Bakery & Confectionery goods
2. Raw materials used in Bakery - Flour - Types of flour - Flour characteristics - Water - Sources - Functions - Usage of Water; Salt - Role of Salt
3. Yeast, Yeast Production - Enzymes - their functions in dough
4. Sugar and Milk - Properties and Role of milk and Sugar in Bakery
5. Leavening agents - What are leavening agents? - Different Leavening agents - their functions in Baking Industry
6. Spices used in baking and their functions; flavoring - Nuts and fruits - their function in bread making
7. Food colours; Setting materials - types - their function in baking; Cocoa and Chocolate

8. Bakery unit operations including mixing - fermentation - Proofing - baking
9. Formula construction and computation of yeast raised products; types of breads, bread faults and remedies
10. Biscuits - Ingredients - Types of biscuits - Processing of biscuits - faults & Remedies
11. Cream crackers, soda crackers, wafer biscuits & matzos, puff biscuits
12. Hard sweet, Semi Sweet and Garibaldi fruit sandwich biscuit
13. Short dough biscuits, Wafers.
14. Cakes - types - Ingredients - Processing of cakes - Problems - Remedies
15. Pizza and pastries - their ingredients and Processing
16. Setting up of a Bakery Unit - Bakery equipment required - types - Selection - Maintenance - Bakery norms and Standards
17. Types of confectionery - Basic technical considerations of confectionery - TSS, pH, Acidity and ERH
18. Raw materials - types of sugar, granulated, caster, liquid brown sugars, molasses, micro crystalline sugars - their role in confectionery
19. Alternative bulk sweeteners - Glucose, fructose, lactose, sugar alcohol, sorbitol, xylitol, Isomalt, poly dextrose - their role in confectionery
20. Enzymes - used in syrup production - used in gelling - enzymes used in whipping
21. Agar-agar, Alginates, carragenons, Gelatin, Acacia gum - Gum Arabic, Pectin, tragacanth, Xanthan gum, Egg albumen and Gelatin as a whipping agent
22. Milk protein, soya protein, oils, fats related products and their role in confectionery
23. Food colours & flavours
24. Chocolate processing - Different steps involved in chocolate processing - Ingredients, mixing, refining.
25. General technical aspects of Industrial sugar confectionery, composition effects, changes, change of state
26. Boiled sweets - classification - Ingredients used in the preparation - Caramel, toffee and fudge - Processing
27. Processing of liquorice paste, cream paste and aerated confectionery products - Ingredients - their function - Ingredients and Processing

28. Tablets, Lozenges, Sugar panning tablets, Granulated confectionery, medicated confectionery - Ingredients and Processing
29. Chewing gums, fondants, Marzipan - Ingredients & Processing
30. Crystallized confectionery - Processing - Ingredients and their functions
31. Quality and standards/Regulations to be followed in the Bakery Industry and packaging requirements
32. Quality and standards/regulations to be followed in the confectionery Industry and packaging requirements

B) Practical Class Outlines

1. Study of different equipments used in Bakery and Confectionery
2. Estimation of Gluten
3. Determination of alcoholic acidity
4. Determination of falling number/amylase
5. Determination of Pelshenke value
6. Determination of sedimentation value
7. Preparation of bread by straight dough methods
8. Preparation of buns by sponge
9. Preparation of yeast dough products - I
10. Preparation of yeast dough products - II
11. Preparation of soda crackers
12. Preparation of Cakes and Cake decorations, cookies
13. Preparation of confectionery, candy, hard boiled candy, cotton candy - I
14. Preparation of confectionery, candy, hard boiled candy, cotton candy - II
15. Preparation of chocolates, chewing gum, bubble gum
16. Visit to bakery and confectionery unit

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DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY

1. Course No. : FDST - 311
2. Title : **Processing of Milk and Milk Products**
3. Credit hours : 3 (2+1)
4. General Objective : To impart knowledge to the students on milk and milk products processing, manufacturing of indigenous milk products, packaging and storage of milk and milk products

5. Specific Objectives

a) Theory

By the end of the course, the students will be able to

- i. Know about milk, its constituents, nutritive value, collection and its hygienic handling practices
- ii. Study about Pasteurization, Homogenization and Sterilization of milk
- iii. Learn about manufacture of cream, butter, ghee, yoghurt, cheese, ice-cream, indigenous milk products and milk confectionery

b) Practical

By the end of the practical exercises, the students will be able to

- i. Develop skills on milk sampling and analysis
- ii. Prepare khoa based products like Kalakhand, Gulabjamun etc and to prepare chhana based products like Paneer, Rasogulla, Sandesh etc
- iii. Understand the milk processing and milk products processing being followed in dairy plants

A) Theory Lecture Outlines

1. Milk - Definition - Indian Standards - Composition - Milk Constituents - Food and Nutritive value of milk
2. Physico-chemical properties of milk constituents - Physico-chemical properties of milk
3. Colostrum and its nutritive value - Milk and Public health - Safe guarding the milk supply - Clean milk production - Buying and collection of milk - Cooling and transportation of milk
4. Effect of heat on milk

5. Manufacture, Packaging and Storage of Pasteurized milk- Receiving - Preheating - Filtration/ Clarification - Cooling - Storage of raw milk
6. Standardization - definition and procedure
7. Pasteurization - Definition - Objectives - Formulation of standards - Methods of Pasteurization- Batch method and HTST method
8. Vacuum Pasteurization - Standardization - Ultra High Temperature Pasteurization - Uperization - Homogenization - Bottling and storage - Flavour defects in milk, their causes and prevention
9. Ultra filtration and Reverse Osmosis
10. Cream - Definition - Classification - Composition - Food and Nutritive value - Physico-chemical properties
11. Cream production - Gravity and Centrifugal methods
12. Factors affecting fat percentage of cream - Yield of cream - Collection of cream - Neutralization of cream
13. Pasteurization of cream - Manufacture of different types of cream - Defects in cream, their causes and prevention
14. Butter - Definition - Classification - Composition - Method of manufacture, packaging and storage - Butter Over run
15. Theories of churning - Continuous butter making - Defects in butter, their causes and prevention
16. Butter oil - Definition - Composition - Nutritive value - Methods of manufacture, Cooling, Packaging, Storage and Distribution - Defects in butter oil, their causes and prevention
17. Special milks - Sterilized milk - Definition - Method of manufacture - Homogenized milk - Definition - Factors influencing homogenization - Method of manufacture - Homogenizer - Soft curd milk - Definition - Characteristics - Methods of preparation of soft curd milk
18. Flavoured milks - Definition - Types - Methods of manufacture of chocolate/fruit flavoured milks/drinks - Vitaminized/Irradiated milk - Frozen concentrated milk
19. Fermented milk - Merits - Types - Starter propagation - Natural butter milk - Cultured butter milk - Acidophilus milk - Bulgarian butter milk - Kumiss - Kefir
20. Yoghurt - Method of preparation - Flavoured yoghurt preparation - Standardized milk - Reconstituted milk - Recombined milk - Toned milk - Double toned milk - Humanized milk - Miscellaneous milks.

21. Cheese - Definition - Classification - Composition - Nutritive value - Manufacture of cheddar cheese - Curing of cheese
22. Cottage cheese - Method of manufacture - Different varieties of cheese - Defects in cheese, their causes and prevention
23. Ice cream - Definition - Classification - Composition - Nutritive value - Role of constituents in ice cream - Method of manufacture, packaging, hardening and storage
24. Over run in ice cream - Defects in ice cream, their causes and prevention
25. Manufacture of indigenous milk products - Ghee, Khoa, Chhana - Method of manufacture, packaging and storage - Nutritive value
26. Paneer, Dahi and Shrikhand - Method of manufacture, packaging and storage
27. Methods of preparation of Kheer, Rabri, Kulfi and Lassi
28. Indian milk confectionery - Manufacturing, packaging and storage of Khoa based sweets Kalakhand and Gulabjamun
29. Manufacturing, packaging and storage of Chhana based sweets Sandesh and Rasogulla.
30. By-products of dairy industry - Classification - Principle and method of utilization
31. Casein (industrial) - method of manufacture - Defects - Uses - Casein (edible) - method of preparation - Uses
32. Packaging and storage of milk and milk products

B) Practical Class Outlines

1. Sampling and analysis of milk-COB, Titratable acidity, alcohol test, fat
2. Study of physico- chemical properties, specific gravity and composition of milk
3. Determination of adulterants and preservatives in milk
4. Separation and standardization of milk
5. Heat processing of milk- Pasteurization
6. Preparation of butter
7. Preparation of ghee
8. Preparation of ice cream
9. Preparation of Dahi and Shrikhand
10. Preparation of Lassi
11. Preparation of Khoa

12. Preparation of Khoa and Khoa based sweets
13. Preparation of Chhana and Paneer
14. Preparation of Chhana based sweets
15. Visit to milk chilling centre
16. Visit to Dairy plant

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DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY

1. Course No. : FDST - 312
2. Title : **Processing of Meat and Poultry Products**
3. Credit hours : 3 (2+1)
4. General Objectives : To enable the students to learn about national and international prospects of Meat industry along with processing and preservation technology of Meat, Egg and Poultry Products

5. Specific Objectives

a) Theory

By the end of the semester the student will get to know

- i. composition and structure of Meat, Egg, Poultry & effective preservation techniques along with concepts of value addition & quality assessment of Meat

b) Practical

By the end of the course, the students will

- i. learn different methods of slaughter, Postmortem changes, preservation techniques and methods of value addition to meat

A) Theory Lecture Outlines

1. Introduction: Sources and development of meat and poultry industries in India and importance of meat and meat industries in national economy
2. Structure of meat muscle-microscopic view - Myofibrils - Actin - Myosin - Contraction.
3. Chemical composition of meat muscle - muscle proteins - fats - carbohydrates - connective tissue-nutritive value of meat.
4. Pre-slaughter care-requirements - different modes of transport of meat animal.
5. Ante-mortem examination of meat animal; principles and judgements.
6. Slaughtering of meat: Scientific methods of slaughter - Stunning techniques - mechanical, electrical, chemical methods; Ritual/religious methods of slaughter - Jewish, Halal, Jhatka and Spanish methods
7. Dressing and cutting of carcass in sheep, pig and buffalo.
8. Post mortem examination of carcass and principles of judgement.
9. Grading of meat and packaging of meat

- 10 Postmortem changes in meat - Rigormortis - Biochemical changes associated with rigormortis which lead to the conversion of muscle to meat - Factors - Ph decline, resolution of rigor-autolytic proteolytic enzymes - microbial invasion and loss of structural integrity
11. Meat quality parameters - Meat color - Water holding capacity - Marbling - Quantum of connective tissue - firmness and storage conditions
12. Palatability characters of meat and factors affecting meat quality
13. Methods of tenderization - aging, enzymes and curing - factors affecting tenderness
14. Spoilage of meat - Sources of contamination, growth of micro organisms - Deteriorative changes in meat - Identification of spoilage
15. Principles of various meat preservation techniques - Chilling - Freezing- Curing - Smoking - Thermal processing - canning - Dehydration - Irradiation and Hurdle concept
16. Processing technology of meat products - Basic processing - Comminution - Mechanical deboning - Emulsification - Meat emulsion - methods of stabilization of meat emulsion- meat extension - preblending - Hot processing - Cooking Techniques
17. Cured meats - Process of curing, methods of curing - commercial processing of ham and Bacon - Sausage processing - Production of Intermediate moisture and shelf stable meat products
18. Restructured meat products - tumbling - massaging - chunking - forming - tearing and forming
19. Value added meat products like luncheon meats - meat patties - meat loaves - meat balls and meat nuggets
20. Safety standards in meat industry - Meat food product order - HACCP-ISO-9000 standards
21. Meat plant sanitation and hygiene
22. Structure of egg - different parts of an egg
23. Composition of egg - Proteins of Egg white, Yolk proteins and lipids and nutritive value of egg
24. Egg quality characteristics - Internal Quality - Haugh's unit - Terms indicating defective quality and Egg grading
25. Antemortem and post mortem examination of poultry birds - principles of judgement
26. Preslaughter care, handling, Transport and dressing of a poultry bird
27. Cuts of poultry bird and Indian Standards of a dressed chicken
28. Microbial spoilage of eggs - types of spoilage in eggs - indications - organisms causing spoilage
29. Preservation and maintenance of eggs - Preservation of shell eggs - Egg cleaning - Oil Treatment - Cold storage - Thermo stabilization - Immersion in liquids

30. Preservation of Albumin and yolk-powder production
31. Preservation of poultry meat - Chilling, Freezing, Curing, Smoking, Dehydration, Canning and Radiation
32. Processing of value added products - Chicken barbecue, chicken sausage, meat balls and pickling

B) Practical Class Outlines

1. Preslaughter operations of meat animals and poultry birds
2. Slaughtering and dressing of meat animals
3. Study of post-mortem changes
4. Meat cutting and handling
5. Evaluation of meat quality
6. Preservation of meat by different methods (dehydration-rehydration-rehydration co-efficient)
7. Preservation of meat by different methods (Freezing-thawing-drip loss)
8. Preservation of meat by different methods (Pickling)
9. Preparation of meat and poultry products
10. Preservation of meat by different methods (Poultry Meat-dehydration-rehydration)
11. Preservation of meat by different methods (poultry meat freezing, pickling)
12. Evaluation of quality and grading of eggs
13. Preservation of shell eggs
14. Identification of deterioration changes in meat & poultry products
15. Visit to slaughter houses - I
16. Visit to slaughter houses - II

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DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY

1. Course No. : FDST - 313
2. Title : **Processing of Spices and Plantation Crops**
3. Credit hours : 3 (2+1)
4. General Objective : To impart knowledge about spice processing and their marketable standards, plantation crops and their importance in Indian economy, post harvest technology of spices, value added products of spices, packaging of processed spices, food, medicinal and pharmaceutical uses of different spices
5. Specific Objectives
 - a) Theory

By the end of the course, the students will be able to

- i. know History of spices, uses of spices, classification of processed spices according to marketing standards, packaging and different grades
- ii. learn about flavor development during processing, classification of spices according to economic importance, post harvest technology and treatments, specifications for marketed products

b) Practical

By the end of the course, the students will be able to

- i. Learn about preparation of value added products
- ii. Study the Quality specifications of spices
- iii. Detect Adulteration of various spices

A) Theory Lecture Outlines

1. Introduction and History of Spices and condiments, production and processing scenario of spices and plantation crops and its scope. Value addition of spices and spice products with different processing methods
2. Definition of major spices, classification of spices, post harvest technology, processed products and their marketing in trade
3. Different technologies involved in the preparation of spice powders, spice oils, oleoresins and micro encapsulated products

4. Standards and specifications of spices, packaging of spices and spice products, market value of spices in India. Herbs and leafy vegetables used as spices and condiments
5. Definition of plantation crops, Commercial value of plantation crops that are grown in India. Garlic- introduction, harvesting, post harvest technology, processing methods, Processed products and its grades
6. Turmeric - Introduction, harvesting, post harvest technology and treatments, processing into marketed products, adulteration, specifications for marketed products, packaging and different grades
7. Onion - Introduction, harvesting, post harvest technology and treatments, processing into marketed products, adulteration, specifications for marketed products, packaging and different grades
8. Pepper- Introduction, harvesting, post harvest technology and treatments, processing into marketed products, adulteration, specifications for marketed products, packaging and different grades
9. All spice and Dil seed - Introduction, harvesting, post harvest technology and treatments, processing into marketed products, adulteration, specifications for marketed products, packaging and different grades
10. Nutmeg and Mace: Introduction, harvesting, post harvest technology and treatments, processing into marketed products, adulteration, specifications for marketed products, packaging and different grades
11. Cassia and Cinnamon : Introduction, harvesting, post harvest technology and treatments, processing into marketed products, adulteration, specifications for marketed products, packaging and different grades
12. Coffee - Introduction, harvesting, post harvest technology and treatments, processing into marketed products, adulteration, specifications for marketed products, packaging and different grades
13. Tea - Introduction, harvesting, post harvest technology and treatments, processing into marketed products, adulteration, specifications for marketed products, Types of tea packaging and different grades
14. Rubber - Introduction, harvesting, post harvest technology and treatments, processing into marketed products, adulteration, specifications for marketed products, packaging and different grades
15. Cocoa - Introduction, harvesting, post harvest technology and treatments, processing into marketed products, adulteration, specifications for marketed products, packaging and different grades

16. Clove and Coriander - Introduction, harvesting, post harvest technology and treatments, processing into marketed products, adulteration, specifications for marketed products, packaging and different grades
17. Annie seed and Fennel seed: Introduction, harvesting, post harvest technology and treatments, processing into marketed products, adulteration, specifications for marketed products, packaging and different grades
18. Chilli - Introduction, harvesting, post harvest technology and treatments, processing into marketed products, adulteration, specifications for marketed products, packaging and different grades
19. Cumin and Ajowan : Introduction, harvesting, post harvest technology and treatments, processing into marketed products, adulteration, specifications for marketed products, packaging and different grades
20. Areca nut - Introduction, harvesting, post harvest technology and treatments, processing into marketed products, adulteration, specifications for marketed products, packaging and different grades
21. Cardamom - Introduction, harvesting, post harvest technology and treatments, processing into marketed products, adulteration, specifications for marketed products, packaging and different grades
22. Sweet basil and Mint - Introduction, harvesting, post harvest technology and treatments, processing into marketed products, adulteration, specifications for marketed products, packaging and different grades
23. Sage and Savory - Introduction, harvesting, post harvest technology and treatments, processing into marketed products, adulteration, specifications for marketed products, packaging and different grades
24. Marjoram and Saffron - Introduction, harvesting, post harvest technology and treatments, processing into marketed products, adulteration, specifications for marketed products, packaging and different grades
25. Oil palm - Introduction, harvesting, post harvest technology and treatments, processing into marketed products, adulteration, specifications for marketed products, packaging and different grades
26. Cashew nut - Introduction, harvesting, post harvest technology and treatments, Processing into marketed products, adulteration, specifications for marketed products, packaging and different grades

27. Vanilla and Annatto - Introduction, harvesting, post harvest technology and treatments, processing and extraction, adulteration, specifications for marketed products, packaging and different grades
28. Thyme and Rosemary - Introduction, harvesting, post harvest technology and treatments, processing into marketed products, adulteration, specifications for marketed products, packaging and different grades
29. Coconut - Introduction, harvesting, post harvest technology and treatments, processing into marketed products, adulteration, specifications for marketed products, packaging and different grades
30. Asafoetida and caraway seed - Introduction, harvesting, post harvest technology, treatments, processing into marketed products, adulteration, specifications for marketed products, packaging and different grades
31. Chemistry of different spice flavors including coffee, tea, vanilla, nutmeg, mace, cinnamon, mint and Ajowan
32. Ginger: Introduction, harvesting, post harvest technology and treatments, processing into marketed products, adulteration, specifications for marketed products, packaging and different grades

B) Practical Class Outlines

1. Identification and characterization of flavouring compounds of spices
2. Identification and characterization of flavouring compounds of spices
3. Extraction of oil from clove, pepper, cardamom, and chilli
4. Extraction of oil from clove, pepper, cardamom, and chilli
5. Extraction of oleoresins- turmeric, ginger, pepper and clove
6. Extraction of oleoresins- turmeric, ginger, pepper and clove
7. Piperine estimation in pepper oleoresin
8. Steam distillation of spices
9. Determination of curcumin content in turmeric
10. Chemical analysis of spices- Moisture, valuable oil, specific gravity, refractive index and acid value
11. Chemical analysis of spices- Moisture, valuable oil, specific gravity, refractive index and acid value
12. Study of standard specifications of spices

13. Preparation of different spice powders
14. Packaging study of spices
15. Visit to cashew processing industry
16. Visit to spice processing industry

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DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY

1. Course No. : FDST - 314
2. Title : **Product Development and Formulation**
3. Credit hours : 2 (1+1)
4. General Objectives : To enable students learn theories and concepts of product development and formulation.
5. Specific Objectives : By the end of the semester

a) Theory

By the end of the course, the students will be able to know

- i. different concepts of product development and formulation, market trends, consumer studies, market testing methods, Launch and commercialization

b) Practical

By the end of the course, the students will specialise in

- i. the area of formulation of new segments of food products for special categories - sports supplements, Diabetic food, Antihypertensive foods etc.,

A) Theory Lecture Outlines

1. Introduction to the Product development and formulation - Need for Product development
2. New food product - Definition - General characteristics of New food product - Classes of new Food products - Line extensions - Repositioning of existing products - New form of existing product - Reformulation - New packaging - Innovative products and Creative products and Value added products
3. Difference between Market and Market places; Customers and Consumers; Marketing Characteristics of the product , Product Life cycle - profit picture
4. Factors affecting food product development - Corporate factors - Market place factors - technological pressures - Governmental issues and legislations
5. Stages/Phases of new product development - Company objectives - Perceived needs of Market - Ideas - Screening - Feasibility studies - Consumer research - Financial review Development - Production - Consumer trials -Test market
6. Generation of Food product Ideas - Sources of new product ideas - The market places - types of market places - With in the company - Outside the market place

7. Consumer studies - types of studies, methods of data collection - Surveys and polling - telephone and mail surveys - focussed group discussions - dephic oracle and Market place analysis and external environment as a source of ideas
8. Organizing for new product development - Concepts of research and development - Creativity
9. Criteria of screening - general criteria for screening - Constraints - financial and technical constraints
10. Development of Strategy from Marketing's Perspective - Marketing functions, market research, Sales and marketability of the product
11. Standardization of product formulation and product design; Adaptable suitable technology role of Engineering in the development process
12. Process design, Scale - up and In - process specifications, Manufacturing plant and Technical aspects and-production trials
13. Market testing - methods of testing - Evaluation
14. Quality assessment of new developed products
15. Costing/pricing and economic evaluation of the product
16. Product launch and commercialization of the product

B) Practical Class Outlines

1. Market survey of existing various products - I
2. Market survey of existing various products - II
3. Formulation of new products based corporate decision
4. Formulation of Protein –energy rich products
5. Formulation of low calorie (Fat replacer) products
6. Formulation products with low sodium content
7. Formulation of Glycemic index based products
8. Formulation of Cholesterolemic index based foods
9. Formulation of Phyto-chemical based Products
10. Product development based on above formulation depending on local sources / Technology - I
11. Product development based on above formulation depending on local sources / Technology- II

12. Product development based on above formulation depending on local sources / Technology - III
13. New product development for Infant /weaning foods, Geriatric, Physiological status, Athletes
14. New product development for Infant /weaning foods, Geriatric, Physiological status, Athletes
15. New product development for Infant /weaning foods, Geriatric, Physiological status, Athletes
16. Quality Assessment of products developed

References

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- Gordon W. Fuller.*New Food Product Development – From concept to market place. Second Edition.* CRC Press.
- Crawford.I.M. *Agricultural and Food Marketing Management*.FAO/UN, Rome.
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DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY

1. Course No. : FDST 315
2. Title : **Processing of Fish and Marine Products**
3. Credit hours : 3 (2+1)
4. General Objectives : To impart knowledge on fisheries and other marine foods, their nutritional composition and processing technologies
5. Specific Objectives
 - a) Theory

By the end of the course, the students will be able to

- i. gain knowledge in the areas of fish and other marine food preservation and processing technology

b) Practical

By the end of the course, the students will

- i. develop practical skills in preservation and processing technology of fish and marine products

A) Theory Lecture Outlines

1. Fisheries resources - Global and Indian Scenario - Types of fishes and other marine products
2. Biochemical composition of fish - prawn and marine fishes - Proximate composition
3. Nutritive value of Fish flesh - prawn and marine foods
4. Types of fish - Anatomy - Deboning process of fish
5. Post-mortem changes in fish and quality assessment - types of fish spoilage - enzymatic - chemical & microbial
6. Spoilage indices of fish - Factors affecting spoilage of fish
7. Onboard handling - Need for hygienic handling - Handling fish onboard - washing - sorting Evisceration- removal of gills - bleeding icing - bulking - shelving and boxing.
8. Drying, Dehydration - principles of drying -Types of drying and types of dryers.
9. Effect of drying on the quality of fish - Spoilage of fish during drying - Advantages - disadvantages
10. Smoking - Preservative action of smoke - composition of smoke - physical and chemical characteristics of smoking agents - Preparation of fish for smoking and smoking process

11. Types of marinades in fish processing
12. Salting - Dry Salting process - Wet salting process
13. Canning of Fish - Canning process - Equipment required - filling - Exhausting - Sealing - Can washing - Thermal processing/sterilization - Advantages
14. Fermentation - Fermented fish products - liquid fermented fish products(Sauces) - Factors affecting quality of fish sauce
15. Fermented fish - method of processing - Lactic acid fermented products
16. Traditional methods - Low temperature storage - Freezing of fish - prawn - process of Freezing - principles of refrigeration - factors affecting - freezing time of fish - Quick freezing
17. Slow freezing methods - equipment required-types - direct and indirect systems - Changes associated with freezing and cold storage of fish
18. Chemical treatments used in fish processing industry
19. Novel Methods - Low dose irradiation& high pressure treatment - Principle - application in fish and prawn processing industry
20. MAP; Vacuum packaging; Gas Packaging - Principle - application in fish and Prawn processing industry
21. Oxygen Absorbents-Carbon dioxide generators - Ethanol vapour - Principle - Application in fish and prawn processing industry
22. Hurdle barrier concept - principle and application in fish processing industry
23. Value added Fish products - What is Value addition? - Types of value added fish Products - Minced fish - Fish finger - Surimi - Fish burger - Fish protein concentrates, cutlets - balls -noodles - flakes
24. Processing of Fish oils - chitosans - fish meal - Isinglass - pearl Essen
25. Fish Packing - Types of packaging used for fish
26. Fish Packing - Types of packaging used for prawn and other sea foods
27. Sea food Quality Assurance - Quality management
28. HACCP - implementation of HACCP in fish and marine processing
29. Quality control and standards for fish, prawn and other sea foods
30. EU hygienic regulations in fish and marine industry

31. ISO 9000 and ISO 14000 certification for standards in fisheries
32. New kinds of quality and safety problems emerging in sea foods processing and Preservation

B) Practical Class Outlines

1. Identification of different types of fish -Selection and Grading
2. Identification of different types of prawn and other marine products -Selection and Grading
3. Study of Anatomy and Dressing of Fish
4. Study of Anatomy and Dressing of Prawn and other Marine products
5. Preservation of Fish- Drying, Pickling
6. Preservation of marine products using fermentation process
7. Preparation of Value added Sea products-Cutlets, Bullets, Wafers
8. Freezing methods for marine fishery products
9. Processing of Fish Oils and other algal products
10. Canning methods for marine fishery products
11. Estimation of TVB and TMA
12. Determination of Iodine value
13. Protein estimation by Folin - Lowrey's method
14. Safety measures for marine fishery foods-FSSA standards, Codex Alimentarius
15. Visit to fish and prawn processing Industry - I
16. Visit to fish and prawn processing Industry - II

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DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY

1. Course No. : FDST - 316
2. Title : **Extrusion Technology**
3. Credit hours : 2 (1+1)
4. General Objective : To impart knowledge to the students about extrusion technology, principle of working, classification of extruders according to process and construction, extruded products and their processing.

5. Specific Objectives

a) Theory

By the end of the course, the students will be able to

- i. learn about use of extrusion technology in food industry
- ii. study about Extrusion cooking, preconditioning of raw material, types of extruders and operating parameters

b) Practical

By the end of the course, the students will be able to

- i. learn about preparation of breakfast cereals and snack foods using extruder
- ii. study processing parameters of extruders for preparing different food products
- iii. prepare extruded products, snack foods and Texturized Vegetable Protein by extruder

A) Theory Lecture Outlines

1. Extrusion : definition, introduction to extruders and their principles, types of extruders
2. Extruders in the food industry: History and uses of extruders in the food industry
3. Single screw extruder: principle of working, net flow, factors affecting extrusion process, co-kneaders
4. Twin screw extruder: counter rotating and co-rotating twin screw extruder
5. Process characteristics of the twin screw extruder : feeding, screw design, screw speed, screw configurations, die design
6. Twin screw extruder: Barrel temperature and heat transfer, adiabatic operation, heat transfer operations and energy balances
7. Problems associated with twin screw extruder

8. Pre-conditioning of raw materials used in extrusion process, Pre-conditioning operations and benefits of pre-conditioning and devolatilization
9. Interpreted-flight expanders - extruders, dry extruders
10. Chemical and nutritional changes in food during extrusion
11. Practical considerations in extrusion processing: pre-extrusion processes, cooker extruder Profiling
12. Practical considerations in extrusion processing: Addition and subtraction of materials, shaping and forming at the die, post extrusion processes
13. Break fast cereals: introduction, type of cooking - High shear cooking process, steam cookers, low shear, low pressure cookers and continuous steam pre-cooking, available brands
14. Break fast cereal processes: traditional and extrusion methods, classification of break fast cereals - flaked cereals, oven puffed cereals, gun puffed cereals, shredded products
15. Texturized vegetable protein: Definition, processing techniques, and foods
16. Snack food extrusion: Direct expanded (DX) and third generation (3G) Snacks: types, available brands, co- extruded snacks and indirect-expanded products

B) Practical Class Outlines

1. Study of different extruders
2. Pre-processing methods for extrusion cooking - I
3. Pre-processing methods for extrusion cooking - II
4. Pre-processing methods for extrusion cooking -III
5. Processing Texturized protein products
6. Processing of Cereal based and Break fast cereal products - I
7. Processing of Cereal based and Break fast cereal products - II
8. Processing of Snack items
9. Processing of Snack items
10. Processing of vegetable based extruded products - I
11. Processing of vegetable based extruded products - II
12. Processing of vegetable based extruded products - III
13. Study of factors affecting extrusion cooking – moisture content, Diameter, temperature, pressure, screw speed, time

14. Study of factors affecting extrusion cooking – moisture content, diameter, temperature, pressure, screw speed, time
15. Study of factors affecting extrusion cooking – moisture content, diameter, temperature, pressure, screw speed, time
16. Quality evaluation of extruded products

References

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- Harper J.M. *Extrusion of Foods*. Vol. 1&2 (1991) CRC Press, Inc; Boca Raton, Florida.
- O'Connor C. *Extrusion Technology for the Food Industry*. (1987) Elsevier Applied Science, New York.

DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY

1. Course No. : FDST - 317
2. Title : **Food Industry By-products**
3. Credit hours : 2 (1+1)
4. General Objectives : To impart knowledge to the student on the food industry by-products like Fruits and vegetables by-products, Cereal by-products utilization

5. Specific Objectives

a) Theory

By the end of the course, the students will be able to

- i. understand the concepts of Agricultural wastes and agro based industries
- ii. understand the industrial application of Food Industry By-Products like Oil seed cake utilization

b) Practical

By the end of the course, the students will be able to

- i. to impart practical knowledge regarding Waste utilization of fruit & vegetables like extraction of pectin from organic waste, extraction of alcohol from molasses

A) Theory Lecture Outlines

1. Introduction to Industrial by - products and waste - Potentials and prospects of developing by-products Industry in India
2. Agricultural wastes and agro based industries - Types of By-products in agro - based industries - commercial compounds obtained from by-products
3. By-products of Cereals - by-products of cereals processing - Rice and corn milling by-products, Husk Utilization
4. By-product utilization of Legume seeds
5. By-products of oilseed Industry - Oil seed cake utilization
6. By-products of dairy industry, Classification, Principle and method of utilization - Whey utilization - demineralization of whey - Lactose preparation, Casein preparation - Utilization of Ghee residue - protein hydrolysates

7. By-products of vegetable and fruit processing Industry - various wastes obtained in different fruit processing industries - pectin extraction from apple pomace - tartaric acid extraction - oxalic acid
8. Fruit pits- kernel oil production, Citrus oil production, Value added products from culled fruit, peels and rinds
9. By-products of fruit and vegetable fermentation - wine and vinegar
10. By-products of meat, poultry and egg processing Industry - Abattoir By-products
11. By-products of meat, poultry and egg processing Industry - Abattoir By-products
12. By-products of fish processing units
13. By-products of spices and plantation crops
14. By-products of Alcoholic Fermentation Industries
15. By-products of Sugar Industry
16. By-products of Bakery Industry

B) Practical Class Outlines

1. Identification of useful products from Fruits and vegetables wastes
2. Identification of useful products from meat and Poultry wastes
3. Extraction of leaf proteins
4. Alcohol production from molasses
5. Extraction of pectin from papaya peel
6. Extraction of pectin from organic waste like orange peel
7. Extraction of Banana fibre
8. Use of crop residues for the production of cellulose
9. Use of mango kernels for starch manufacture
10. Pectin from organic waste
11. Rice bran utilization for edible grade oil extraction
12. Rice bran utilization for edible grade oil extraction
13. Extraction of volatile oils from organic waste from Agro processing Industries
14. By-products utilization of poultry, fish, meat from Agro processing Industries
15. By-products utilization of Milk, wastes from Agro processing Industries
16. By-products utilization of cereals, pulses and oilseed wastes from Agro processing Industries

References

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- Giridharlal, Siddappa and GL Tandon, ICAR. *Preservation of fruits and vegetables*, New Delhi.
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- Ervan. *Food from Wastes*.
- Sharma, B.D. Modern Abattoir Practices and *Animal by Products Technology*, Jaypee Brothers Medical Publishers Pvt. Ltd, New Delhi
- P. Chereminst. *Food Protein sources - Fire Energy from Solid Waste*
- B.H. Webb and E.O. Whittier, *By-Products from Milk* - AVI Publishers Co., West port, Connecticut, USA.

DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY

1. Course No. : FDST - 318
2. Title : **Food Quality and Certification**
3. Credit hours : 3 (2+1)
4. General Objectives : To enable students learn concepts of food quality and certification and role of food quality in keeping up Indian and International standards in the food industry.

5. Specific Objectives

a) Theory

By the end of the course, the students will

- i. get awareness in quality assessment of various processed foods-quality standards pertaining to food industry.

b) Practical

By the end of the course, the students will

- i. learn techniques of quality assessment for different varieties of foods along with subjective and objective methods of quality judgement

A) Theory Lecture Outlines

1. Food Quality - its need and its role in Food Industry
2. Food Quality and Quality Attributes - Classification of Quality Attributes and their role in food Quality
3. Objectives, Importance and Functions of Quality Control
4. Methods of quality concepts of Dough Rheology
5. Quality Assessment of Food materials - Fruits and Vegetables
6. Quality Assessment of Food materials - Cereals and legumes
7. Quality Assessment of Food materials - Dairy Products / Milk and Milk Products
8. Quality Assessment of Food materials - Meat, Poultry, Egg and Processed food Products
9. Statistical Quality Control of Foods
10. Sensory Evaluation of Food Quality - Introduction - Panel Screening - Selection of Panel members

11. Requirements for conducting Sensory Evaluation and serving procedures
12. Methods of Sensory Evaluation and Evaluation cards - Difference/discrimination procedures
13. Methods of Sensory Evaluation and Evaluation cards - Ranking and Rating procedures
14. Different methods of Quantitative descriptive analysis
15. Determination of Sensory thresholds and taste Interactions
16. Objective/Instrumental analysis of Quality Control
17. Food laws and Standards (BIS)
18. Consumer Studies - Types of Consumer studies - Preference Studies and Acceptance Studies
19. Consumer Studies - Types of Consumer studies - Preference Studies - Objectives of Consumer Preference Studies - factors affecting consumer acceptance
20. Information obtained from Consumer Study - Factors Influencing results from Consumer surveys
21. Methods of Approach - Development of the questionnaire - Types of Questionnaire and other methods of data collection
22. Comparison of Laboratory Panels with Consumer panels. Limitations of Consumer Survey
23. Fundamentals of Food regulations - pertaining to Additives and Contaminants
24. Food regulations pertaining to aspects of Hygiene - Novel Foods & aspects of Labelling
25. Different existing Food legislations-norms in implementation
26. Food grade and standards
27. International food regulations and certifications
28. Indian food regulations and Certifications
29. Concept of Codex Alimentarius
30. The concept and process of implementation of HACCP in an industry
31. USFDA - the cause of its existence - it's role in safe guarding food quality - ISO9000 series - Significance
32. Food Adulteration and Food Safety

B) Practical Class Outlines

1. Techniques of quality assessment of Fruits and vegetables.

2. Techniques of quality assessment of Cereals and legumes.
3. Techniques of quality assessment of Dairy products.
4. Techniques of quality assessment of meat, poultry, milk and other processed products
5. Selection and training of sensory panel
6. Hedonic rating of Food
7. Identification and ranking of Food product attributes
8. Sensory and Instrumental methods for measuring food attributes
9. Testing different foods for adulterants
10. Determination of threshold value for basic tastes –sweetness and sourness
11. Determination of threshold value for basic tastes -Salt and bitterness
12. Odour identification procedure
13. Judging and grading of canned food products
14. Judging and grading of other processed food products
15. Visit to a certification agency
16. Visit to fruit and vegetable market for quality assessment

References

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- Amerine, Pangborn. M.A. and Roseiur.*Principles of Sensory Evaluation of Food*.
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- Pattee.*Evaluation of Food quality of fruits and vegetables*. AVI publishers, Westport.
- Ranganna.S . *Handbook of Analysis and Quality Control – Fruits and Vegetable Products*. Tata
Mc Graw Hill, New Delhi
- BIS standards on *Sensory Evaluation*

DEPARTMENT OF FOOD ENGINEERING

1. Course No. : FDEN - 121
2. Title : **Principles of General Engineering**
3. Credit hours : 3 (2+1)
4. General Objectives : To impart knowledge to the students on basic electrical Engineering, Material Science, Strength of materials and Food Processing Equipment

5. Specific Objectives

a) Theory

By the end of the course the students, will be able to

- i. Gain knowledge and skills on electromagnetic induction, AC Circuits, Transformers, AC and DC generators, AC and DC Motors, basic knowledge on building materials and Design and selection of Food Processing Equipment

b) Practical

By the end of the practical exercises, the student will be able to

- i. Get skills required for basic Electrical Engineering

A) Theory Lecture Outlines

1. Electromagnetic induction - relation between magnetism and Electricity. Faraday's Laws, Production of induced e.m.f and current, related problems
2. Fleming's Right hand rule, Lenzy's Law, magnitude of induced e.m.f., mechanism of Electro magnetic induction, Electromagnetic machines
3. Alternating current, direct current, advantages and disadvantages, production of alternating e.m.f., A.C generator, phase, phase difference
4. Mean or Average value of an alternating current and its derivation, Root Mean Square (RMS) value of alternating current, derivation
5. Alternating current with Resistance, Inductance and capacitance including derivation
6. A.C circuit with inductance, capacitance and Resistance and its derivation, Resonance circuits, Series and parallel resonance circuits
7. Wattmeter, measurement of A.C frequency with sonometer, distribution of 3 - phase current, STAR connection, Delta Connection

8. Poly phase A.C. circuits - Generation of poly phase, single phase, two phase, three Phase concept, advantages of poly phase over single phase
9. Measurement of 3-phase power, single Wattmeter method, two Wattmeter method, Three Wattmeter method
10. Transformers - fundamentals of transformer, transformation ratio
11. Transformer with load and without load, energy losses in transformers, Efficiency of transformer, types of transformers, auto-transformer
12. Induction motors - fundamental principles, production of rotating fields, two phase supply, three phase supply
13. Construction of 3-phase induction motor, stator, squirrel cage rotor, phase wound rotor
14. Principle of operation of induction motor, starting of induction motor
15. Selection of motors and its control
16. D.C generator - working principle of D.C generator, single loop generator, slip rings, split rings
17. Construction of D.C generator, Yoke, pole cores, field winding, Brushes, Armature core
18. Armature winding - lap winding, wave winding, terms used in armature winding, commutator
19. EMF equation of D.C generator, types of generators, separately excited generators, self excited generators
20. D.C motors - Construction of D.C motor, back EMF, Torque equation of D.C motor
21. Speed equation of D.C motor, characteristics of D.C motor, starting and speed control of D.C motor
22. A.C generators - Startor, rotor, working principle, salient pole type rotor, smooth cylindrical type rotor
23. EMF equation of A.C generator, Electric power Economics, Demand - Average demand, Maximum demand
24. Load factor, power factor, power factor correction
25. Simple stress and strain - stress, strain, tensile stress, compressive stress, Elastic limit, Hooks law, deformation of body due to force acting on it
26. Principle of superposition, stress in bars of varying sections, stress in bar due to its own weight

27. Elastic constants - primary strain, secondary strain, poisson's ratio, volumetric strain, bulk modulus, shear modulus
28. Relation between the bulk modulus and young's modulus, relation between the modulus of elasticity and modulus of rigidity
29. Use of various metals, plastic, glass etc. in food industry
30. Material design, manufacturing of various equipments and machineries in food processing plant
31. Characteristics, properties and uses of stone, brick and lime
32. Characteristics, properties and uses of steel, cement, paints and varnishes

B) Practical Class Outlines

1. Study of voltage resonance in L.C.R. circuits at constant frequency
2. Study of voltage and current relation of Star and Delta connections
3. Measurement of power in 3-phase circuits for balance loads and unbalanced loads by wattmeter and energy meters
4. Polarity test, No load test, efficiency and regulation test of single phase
5. Voltage and current relation in a 3- phase transformer of various kinds of primary and secondary connections systems
6. Starting of induction motor by D.O.L starters
7. Starting of induction motor by Manual star-delta
8. Starting of induction motor by Manual auto-transformer
9. Starting of induction motor by Automatic star-delta starter
10. Starting of slip-ring induction motor by normal and automatic rotor starters
11. Test on 3-phase induction motor, determination of efficiency, speed
12. Determination of power factor, slip, line current at various outputs of 3-phase induction motor
13. To determine the relation between the induced armature voltage and speed of separately excited DC generator
14. Magnetization characteristic of DC generator
15. Study the starter connection and starting, reversing and adjusting speed of a DC motor -I
16. Study the starter connection and starting, reversing and adjusting speed of a DC motor -II

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DEPARTMENT OF FOOD ENGINEERING

1. Course No. : FDEN - 122
2. Title : **Engineering Drawing**
3. Credit hours : 2 (0+2)
4. General Objectives : To understand how to represent the product graphically before manufacture and also to understand how to develop the optimum design
5. Specific Objectives :
 - a). Theory
No theory component
 - b) Practical

By the end of the course, the students will be able to

- i. understand how to know exact shapes of components
- ii. understand how to develop the surfaces of components

A) Theory lecture Outlines

No theory component

B) Practical Class Outlines

1. Introduction of drawing scales - I
2. Introduction of drawing scales - II
3. Principles of orthographic projection - I
4. Principles of orthographic projection - II
5. Principles of orthographic projection - III
6. Reference planes - I
7. Reference planes - II
8. Points and lines in space and traces of lines and planes - I
9. Points and lines in space and traces of lines and planes - II
10. Points and lines in space and traces of lines and planes -III
11. Auxiliary planes and true shapes of oblique plain surface - I

12. Auxiliary planes and true shapes of oblique plain surface - II
13. Auxiliary planes and true shapes of oblique plain surface - III
14. True length and inclination of lines - I
15. True length and inclination of lines - II
16. True length and inclination of lines - III
17. Projections of solids(change of position method, alteration of ground lines) - I
18. Projections of solids(change of position method, alteration of ground lines) - II
19. Projections of solids(change of position method, alteration of ground lines) - III
20. Section of solids and interpenetration of solid-surfaces - I
21. Section of solids and interpenetration of solid-surfaces - II
22. Section of solids and interpenetration of solid-surfaces - III
23. Development of surfaces of geometrical solids - I
24. Development of surfaces of geometrical solids - II
25. Development of surfaces of geometrical solids - III
26. Development of surfaces of geometrical solids - IV
27. Isometric projection of geometrical solids - I
28. Isometric projection of geometrical solids - II
29. Isometric projection of geometrical solids - III
30. Isometric projection of geometrical solids - IV
31. Isometric projection of geometrical solids - V
32. Isometric projection of geometrical solids - VI

References

- Luzardder W J. 1988. Fundamentals of Engineering Drawing - Prentice Hall of India Pvt., Ltd., New Delhi
- Bhatt N D. 1995. Elementary Engineering Drawing - Charotar Publishing House, Anand.
- Narayana K L., Kannaiah P and Venkata Reddy K .1996. Engineering Drawing - New Age International Limited, New Delhi.

DEPARTMENT OF FOOD ENGINEERING

1. Course No. : FDEN - 123
2. Title : **Energy Generation & Conservation**
3. Credit hours : 3 (2+1)
4. General Objective : To impart knowledge to the students on basic concepts and applications of Thermodynamics in Engineering problems, Renewable Energy sources and their utilization in Food Processing, Steam generation and use of boilers in food industries, Indian Boiler's Act and Indian Boiler Regulation
5. Specific Objectives
 - a) Theory

By the end of the course, the students will be able to

- i. understand the basic concepts of Thermodynamics, Thermodynamic systems, Thermodynamic cycles and Laws of Thermodynamics
- ii. learn about renewable energy sources like Solar, Wind and Biogas and their applications in food industries
- iii. gain knowledge on steam and its formation, fuels used for combustion, steam boilers and their types, mountings and accessories and Indian Boiler's Act

b) Practical

By the end of the practical exercises, the students will be able to

- i. solve engineering problems by the application of Thermodynamics
- ii. study the different types of boilers and determine the calorific value of fuels
- iii. learn the applications of solar energy based appliances, wind mills and biogas plants

A) Theory Lecture Outlines

1. Thermodynamics - Definition - Thermodynamic systems - Classification of Thermodynamic systems - Properties of a system - Classification of properties of a system - State of a system - Path of change of state - Thermodynamic Process - Thermodynamic Cycle or Cyclic process
2. Energy - Types of stored energy - Law of conservation of energy - Heat - Specific heat - Thermal or heat capacity - water equivalent - Mechanical equivalent of heat

3. Laws of Thermodynamics - Zeroth law of Thermodynamics - First law of Thermodynamics - Second law of Thermodynamics - Refrigerator and heat pump - Coefficient of performance
4. Ideal gas - Equation of state - General laws for expansion and compression - Enthalpy of gas
5. Second law of Thermodynamics - Absolute thermodynamic temperature scale - Carnot cycle - Entropy - Reversibility and irreversibility
6. Renewable energy sources - Solar energy utilization - Biomass - Biogas - Anaerobic digestion of organic matter - Application of biogas
7. Types of biogas plants - Floating dome type - Fixed dome type - KVIC model, Janata model - Deenbandhu model - Running the plant - Maintenance of biogas plant
8. Wind energy - Applications of wind mill - Advantages and disadvantages of wind energy - Types of wind mills - Savonius wind mill - Darrieus wind mill - Single blade wind mill - Two blade wind mill - Multi blade wind mill - Sail type wind mill
9. Solar energy - Advantages and disadvantages - Solar energy utilization - Flat plate collector - Concentrating collector - Cylindrical parabolic concentrating collector - Paraboloid concentrating collector
10. Natural Circulation water heating system - Forced circulation water heating system - Space heating - Space cooling and refrigeration - Drying - Cabinet dryer - Convective dryer - Cooking - Solar distillation.
11. Fuels - Introduction - Classification of fuels - Solid fuels - Liquid fuels - Merits and demerits of liquid fuels over solid fuels
12. Gaseous fuels - Merits and demerits of gaseous fuels - Requirements of a good fuel - Calorific value of fuels - Gross or higher calorific value - Net or lower calorific value
13. Experimental determination of higher calorific value - Bomb calorimeter - Boy's gas calorimeter - Problems on calorific values
14. Combustion of fuels - Introduction - Combustion equations of solid fuels - Combustion equations of gaseous fuels
15. Theoretical or minimum mass of air required for complete combustion - Theoretical or minimum volume of air required for complete combustion - Problems on theoretical mass/volume of air required for combustion
16. Conversion of volumetric analysis into mass analysis or gravimetric analysis - Conversion of mass analysis into volumetric analysis - Mass of carbon in flue gases - Mass of flue gases per kg of fuel burnt

17. Problems on determination of mass of dry flue gases - Excess air supplied - Mass of excess air supplied - Flue gas analysis by Orsat apparatus
18. Burners - Pulverized fuel burners - Long flame burners - Turbulent burners - Tangential burners - Cyclone burners - Advantages
19. Oil burners – Principle of oil firing - Classification of oil burners - Vaporising oil burners - Atomizing fuel burners
20. Gas burners - Advantages
21. Formation and properties of steam - Introduction - Temperature vs. total heat graph during steam formation - Wet steam - Dry saturated steam - Super heated steam - Dryness fraction - Sensible heat of water - Latent heat of vaporization - Enthalpy of steam - Specific volume of steam
22. Steam tables and their uses - Super heated steam - Problems on enthalpy of steam - Advantages of super heating the steam
23. Steam Boilers - Introduction - Important terms for steam boilers - Essentials of a good steam boiler - Selection of a steam boiler - Classification of steam boilers
24. Simple vertical boiler - Cochran boiler - Scotch marine boiler - Lancashire boiler - Cornish boiler
25. Locomotive boiler - Babcock and Wilcox boiler - Water tube and fire tube boilers
26. Boiler mountings viz., Water level indicator, Pressure gauge, Safety valve, Stop valve, Blow off cock, Feed check valve, Fusible plug - their functions. Boiler accessories viz., feed pump, super heater, economizer, air - pre heater - their functions
27. Performance of steam boilers - Equivalent evaporation - Boiler efficiency - Problems on boiler efficiency
28. Boiler trial - Heat losses in a boiler - Heat balance sheet
29. Boiler draught - Classification of draughts - Types of draughts - Advantages and disadvantages of mechanical draught - Comparison between forced draught and induced draught - Height of chimney - Problems on draught of chimney
30. Condensers - Advantages - Requirements of a steam condensing plant - Classification of condensers
31. Indian Boiler's Act -1923 - Insulation of steam piping - Pipe expansion bends
32. Compressors - Classification of air compressors - Working of single stage reciprocating air compressor - Two stage reciprocating air compressor with intercooler

B) Practical Class Outlines

1. Application of Thermodynamics in Engineering problems
2. Application of Thermodynamics in Engineering problems
3. Application of Thermodynamics in Engineering problems
4. Determination of dryness fraction of steam by Barrel Calorimeter
5. Determination of dryness fraction of steam by Separating Calorimeter
6. To study the boiler installed in Model plant and Water softening plant
7. To study the Lancashire Boiler and Locomotive boiler
8. To study the Babcock and Wilcox boiler and Electrode boiler
9. To study boiler mounting, steam-line layout and steam traps
10. Visit to rice mill or plant with steam installation
11. Visit to sugar mill or plant with steam installation
12. Study of Solar water heater
13. Study of biogas plants and appliances
14. Determination of calorific value of coal
15. Determination of calorific value of agricultural waste and other fuels
16. Inspection and maintenance of boilers

References

Khurmi, R.S. *A Text book of Thermal Engineering*. S.Chand and Company Co. Ltd., New Delhi.

Nag, P.K. *Engineering Thermodynamics*. 4th Edition. Tata McGraw Hill, India.

Rai, G.D. *Non Conventional Energy Sources*. Khanna Publishers, New Delhi.

Rajput, R.K. *A Text Book of Power Plant Engineering*. Laxmi Publications, India.

Sukhatme. *Solar Energy*. Tata McGraw Hill Publishers, India.

DEPARTMENT OF FOOD ENGINEERING

1. Course No. : FDEN - 124
2. Title : **Workshop Practice**
3. Credit hours : 2 (1+1)
4. General Objectives :
 - i. To understand how to join two objects as strong as base one
 - ii. To understand how to prepare containers
 - iii. To understand how to make wooden furniture
 - iv. To understand how to make storage tanks
5. Specific Objectives
 - a) Theory

By the end of the course, the students will be able to

- i. understand how to join two objects as strong as base one
- ii. understand how to make wooden furniture

b) Practical

By the end of the course, the students will be able to

- i. understand how to make things with lowest cost
- ii. understand how to make things which have high strength

A) Theory Lecture Outlines

1. Simple exercises on working tools and their use
2. Carpentry and pattern making
3. Mould material and their applications
4. Heat treatment processes - hardening - tempering
5. Annealing - normalizing - metal cutting.
6. Soldering - brazing
7. Electric arc welding
8. Gas welding
9. Smithy and forging operations
10. Bench - flat surface filling, chipping

11. Scraping marking out
12. Drilling and screwing
13. Use of jigs and fixtures in production - simple exercise on - lathe
14. Milling machine
15. Shaper and planer
16. Drilling - boring machines and grinder

Practical Class Outlines

1. Practicing of fitting a square plate
2. Preparation of a circular disc
3. Preparation of square joint
4. Preparation of square joint
5. Preparation of "T" joint
6. Preparation of dove tail joint
7. Butt welding of two pieces
8. Simple exercise in arc welding pieces
9. Simple exercise in gas welding
10. Simple exercise in argon welding
11. Simple exercise in soldering
12. Simple exercise in tapping
13. Simple exercise in brazing
14. Preparation of T-lap joint in carpentry
15. Preparation of mortise and tenon joint in carpentry - I
16. Preparation of mortise and tenon joint in carpentry - II

References

- Hazra Choudari, S. K. and Bose. *Elements of Workshop Technology* (vol.I and II). 1982. Media Promoters and Publishers Pvt. Ltd., Mumbai.
- Chapman, W .A. J. *Workshop Technology* (Part I and II) 1989. Arnold Publishers (india) Pvt. Ltd., AB/9 Safdarjung Enclave, New Delhi.
- Raghuwamsi, B. S. *A Course in Workshop Technology* (vol. I and II). 1996. Danpat Rai and Sons, Nai Sarak, New Delhi.

DEPARTMENT OF FOOD ENGINEERING

1. Course No. : FDEN - 125
2. Title : **Fluid Mechanics & Hydraulics**
3. Credit hours : 2 (1+1)
4. General Objectives : To enable the students to design efficient water conveyance systems like canals, channels and pipes from places of origin to delivery points by acquiring knowledge on the principles of mechanics of fluids, water measurement and regulation
5. Specific Objectives
 - a) Theory

By the end of the course the students will be able to

- i. gain knowledge on Bernoullies theory, Buckingham's Pi theorem, Darcy's and Chezy's theorm
- ii. gain the knowledge on mechanical gauges, flow of fluids in the pumps, and Archimedes principles and theory
- iii. understand flow through mouth pieces, flow through orifices and pumps

b) Practical

By the end of the course the students will be able to

- i. know the measurement of fluid pressure, measurement of discharge and measurement of time
- ii. know how to determine the Coefficient of discharge from the pitot tube experiment
- iii. know how to measure the water level from 'U' tube manometer

A) Theory Lecture Outlines

1. Fluids - definitions-classification - properties, units and dimensions - fluid pressure - Introduction - Measurement of fluid pressure - Hydraulic pressure, absolute and gauge pressure - pressure head of the liquid
2. Pressure on vertical rectangle surfaces - Compressible - non compressible fluids - surface tension and capillarity
3. Pressure measuring devices- simple, micro, inclined manometers
4. Mechanical gauges - piezometer - floating bodies - Archimedis principle-stability of floating bodies

5. Equilibrium of floating bodies - Buoyancy of flotation - metacentric height - Kinematics of fluid flow - introduction - classification of flows - steady, uniform, non uniform, laminar and turbulent - continuity of fluid flow
6. Bernoulli's theorem and its applications
7. Practical applications of Bernoulli's theorem, Venturimeter, Pitot tube, Orifice meter and rotameter
8. Flow through simple pipes - Loss of head in pipes, Darcy's formula for loss of Head in pipes, Chezy's formula for loss of head in pipes - determination of pipe diameter - determination of discharge - friction factor - critical velocity
9. Flow through orifices (Measurement of Discharge) - Types of orifices, Jet of water, vena contract, Hydraulic coefficients, Experimental Method for Hydraulic Coefficients, Discharge through a rectangular orifice
10. Flow through Mouthpieces - Types of Mouthpieces - Loss of Head of a liquid flowing in a pipe, Discharge through a Mouthpiece - flow over weirs - Types of weirs, Discharge over a weir
11. Flow through Orifices (Measurement of Time) - Time of Emptying a square, rectangular or circular tank through an orifice at its bottom, Time of emptying a Hemispherical tank through an orifice at its bottom
12. Flow through Weirs (Measurement of Time) - Time of Emptying a square, rectangular or circular tank through an orifice at its bottom, Time of emptying a Hemispherical tank through an orifice at its bottom
13. Loss of head due to contraction - enlargement at entrance and exit of the pipe-water level point gauge - Hook gauge
14. Flow over Notches - Types of Notches, Discharge over a Rectangular Notch, Triangular Notch, Stepped Notch. Time of emptying a tank over a Rectangular Notch, Triangular Notch
15. Dimensional analysis and similitude - Buckingham's pi theorem - Froude Number, Reynolds number, Weber number and hydraulic similitude
16. Pumps-classification - reciprocating - centrifugal pumps - pressure variation, work efficiency - types of chambers - selection and sizing

B) Practical Class Outlines

1. Study of different tools and fittings
2. To plot flow rate versus pressure drop with U-tube manometer
3. Verification of Bernoulli's theorem

4. Determination of discharge co-efficient for venturi
5. Determination of discharge co-efficient for Orifice
6. Determination of discharge coefficient of V-Notch
7. Verification of emptying time formula for a tank
8. Determination of critical Reynold's number by Reynold's apparatus
9. Study of reciprocating, centrifugal and gear pumps.
10. Calibration of Rotameter
11. Study of different types of valves
12. Problems on venturimeter
13. Problems on orifices
14. Problems on flow through pipes
15. Problems on pumps
16. Problems on weirs

References

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- Chow, V. T. 1983. *Open Channel Hydraulics*, Mc Graw Hill Book Co., New Delhi
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DEPARTMENT OF FOOD ENGINEERING

1. Course No. : FDEN - 221
2. Title : **Heat & Mass Transfer**
3. Credit hours : 2 (1+1)
4. General Objectives : To impart knowledge to students on different modes of heat transfer through extended surfaces, study of heat exchanges and principles of mass transfer

5. Specific Objectives

a) Theory

By the end of the course, the students will

- i. acquire knowledge from different modes of heat transfer, extended surfaces, boiling and condensation process and principles of heat exchangers which are very essential in dairy and food industries

b) Practical

By the end of the course, the students will

- ii. learn efficient design of heat exchangers on the basis of overall heat transfer co-efficient and LMTD

A) Theory Lecture Outlines

1. Basic heat transfer process, thermal conductivity, convective film co-efficient, Stefan Boltzman's constant, overall heat transfer coefficient
2. Physical properties related to heat transfer, one dimensional steady state conduction, Theory of heat conduction, Fourier's law, Derivation of Fourier's equation
3. Linear heat flow through slab, cylinder and sphere, heat flow through slab, cylinder and sphere with non-uniform thermal conductivity
4. Concept of electrical analogy and its applications for thermal circuits, heat transfer through composite walls and insulated pipelines
5. One dimensional steady state heat conduction with heat generation, heat flow through slab, sphere, cylinder with uniform heat generation
6. Development of equations of temperature distribution with different boundary conditions
7. Steady state heat conduction with heat dissipation to environment-Introduction to extended surfaces (FINS) of uniform area of cross section

8. Equation of temperature distribution with different boundary conditions, Effectiveness and efficiency of the FINS
9. Introduction to unsteady state heat conduction, Convection, types of convection, use of dimensional analysis for correlating variables affecting convective heat transfer
10. Concept of Nusselt's number, Prandtl number, Reynold's number, Grashoff number, some important empirical relations used for determination of heat transfer coefficient
11. Radiation - heat radiation, emissivity, absorptivity, transmissivity, radiation through black and grey surfaces, determination of shape factors
12. Introduction to condensing and boiling heat transfer, Film and dropwise condensation, effect of non condensable gases, boiling heat transfer
13. Heat exchangers- general introduction, fouling factors, jacketed kettles, LMTD, parallel and counter flow heat exchangers
14. Shell and Tube and plate heat exchangers, heat exchanger design, application of different types of exchangers in dairy and food industry
15. Mass transfer- introduction, Fick's law of diffusion, steady state diffusion of gases and liquids through solids
16. Equimolar diffusion, isothermal evaporation of water into air, mass transfer coefficient, application in Dairy and Food industry

B) Practical Class Outlines

1. Determination of thermal conductivity of milk and dairy products
2. Tutorials on heat conduction through slab, cylinder and sphere
3. Tutorials on heat conduction through slab, cylinder and sphere
4. Tutorials on heat conduction through slab, cylinder and sphere
5. Tutorials on extended surfaces (FINS)
6. Tutorials on unsteady state heat conduction
7. Determination of specific heat of food materials
8. Tutorials on determination of Nusselt's number by dimensional analysis
9. Tutorials on LMTD and NTU method of analysis of heat exchangers
10. Study of shell and tube heat exchanger
11. Study of plate heat exchanger

12. Study on temperature distribution and heat transfer in HTST pasteurizer
13. Study on temperature distribution and heat transfer in HTST pasteurizer
14. Design problems on heat exchangers - I
15. Design problems on heat exchangers - II
16. Design problems on heat exchangers - III

References

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- Holman, J. P. 1989. *Heat Transfer*. McGraw Hill Book Co., New Delhi.
- Incropera, F. P. and De Witt, D .P. 1980. *Fundamentals of Heat and Mass Transfer*. John Wiley and Sons, New York.
- Gupta, C. P. and Prakash, R. 1994. *Engineering Heat Transfer*. Nem Chand and Bros., Roorkee

DEPARTMENT OF FOOD ENGINEERING

1. Course No. : FDEN - 222
2. Title : **Refrigeration Engineering & Cold Chain**
3. Credit hours : 3 (2+1)
4. General Objectives
 - i. To know the equipments available to store perishable items for a long time
 - ii. To understand to increase the storage life of food items
5. Specific Objectives
 - a) Theory

By the end of the course, the students will

- i. understand the different equipments useful to store the food items for a long period.
- ii. understand to increase the storage life of food items

b) Practical

By the end of the course, the students will

- i. understand the different parts of refrigeration system
- ii. know the quality changes in foods during freezing storage

A) Theory Lecture Outlines

1. Definition of refrigeration and air conditioning - Necessity of refrigeration and air conditioning - Factors affecting comfort air conditioning
2. Definition of Refrigerant - History of refrigerants - Classification of Refrigerants - Primary Refrigerants - Secondary Refrigerants - Halo carbon refrigerants
3. Azeotrope refrigerants - Inorganic refrigerants - Ammonia - Air - Carbon dioxide - Sulphur dioxide - Water
4. Hydro carbon refrigerants - Designation system for refrigerants
5. Desirable properties of an ideal refrigerant - Selection of a refrigerant
6. Thermodynamic properties of refrigerants
7. Chemical requirements of refrigerants - Physical properties of refrigerants
8. Secondary refrigerants - Brines

9. Types of Refrigerators - Air Refrigerator - Vapour refrigerator - Advantages and Disadvantages of Vapour compression refrigeration system over air refrigeration system
10. Mechanism of a simple Vapour compression refrigeration systems
11. Evaporators - Capacity of an evaporator - Factors affecting heat transfer capacity of an evaporator - Types of evaporators
12. Bare tube coil evaporator - Finned evaporator - Plate evaporator - Shell and tube evaporator
13. Shell and coil evaporator - Tube in tube evaporator - Flooded evaporator - Dry expansion evaporator
14. Natural convection evaporator - Forced convection evaporator - Frosting evaporators - Non Frosting evaporators - Defrosting evaporators
15. Compressors - Classification - Suction pressure, Discharge pressure, Compression ratio, Suction volume, Stroke volume, Clearance factor, Compressor capacity, Volumetric efficiency
16. Reciprocating compressors - Parts of a reciprocating compressor - Cycle of a reciprocating compressor
17. Rotary compressor - Centrifugal compressor - Advantages and disadvantages of a centrifugal compressor
18. Condensers - Working of a condenser - Factors affecting the condenser capacity - Heat rejection factor
19. Classification of condensers - Air cooled condensers - Water cooled condensers - Tube in tube condenser - Shell and coil condenser
20. Fouling factor - Differences between air cooled and water cooled condensers - Evaporative condenser
21. Expansion Devices - Types of expansion devices - Capillary tube
22. Hand operated expansion valve - Low side float valve - High side float valve
23. Ice manufacture - principles of ice production
24. Applications of refrigeration in different food products
25. Fruit and vegetable products
26. Meat products - fish - poultry products - dairy products
27. Food Freezing - Freezing systems - Indirect contact systems
28. Plate Freezers - air blast Freezers - Freezers for liquids foods
29. Direct contact systems - Air blast - Immersion

30. Frozen food properties - Density - Thermal conductivity - Enthalpy - Apparent specific heat - Apparent thermal diffusivity
31. Freezing time - Factors influencing freezing time - Freezing rate - Thawing time
32. Quality changes in foods during frozen storage

B) Practical Class Outlines

1. Study of vapour compression refrigeration system
2. Study of vapour compression refrigeration system
3. Tutorials on cooling load calculations
4. Tutorials on cooling load calculations
5. Numerical on air refrigeration cycle systems
6. Study the properties and performance characteristics of some commonly used Refrigerants
7. Study the properties and performance characteristics of some commonly used Refrigerants
8. Study the components of the refrigeration system
9. Study the components of the refrigeration system
10. Study the freezing of foods by different methods
11. Study the freezing of foods by different methods
12. Determination of freezing time of food materials
13. Determination of freezing time of food materials
14. Study of quality changes in foods during freezing storage - I
15. Study of quality changes in foods during freezing storage - II
16. Study of quality changes in foods during freezing storage - III

References

- Adithan, M. and Laroia, S. C. 1991. *Practical Refrigeration and Air Conditioning*. Wiley Eastern Ltd., New Delhi
- Arora, C. P. 1993. *Refrigeration and Air Conditioning*. Tata MC Graw Hill Publishing Co.Ltd., New Delhi.

DEPARTMENT OF FOOD ENGINEERING

1. Course No. : FDEN - 223
2. Title : **Food Processing Equipment-I**
3. Credit hours : 3 (2+1)
4. General Objective : To impart knowledge to the students on principles, operation and maintenance of various food processing equipments namely material handling equipment, cleaning, grading, sorting, mixing, forming, size reduction, centrifugation, filtration, evaporation, drying, cutting and grinding equipments.

5. Specific Objectives

a) Theory

By the end of the course, the students will be able to

- i) understand different food processing equipments that are being used in food industries
- ii) study about the principles, operation and maintenance of food processing equipments viz., material handling, cleaning, grading, mixing, forming, size reduction, cutting, grinding, centrifugation, filtration, evaporation and drying

b) Practical

By the end of the course, the students will be able to

- i) determine the Engineering properties of food materials
- ii) solve design problems on heat exchangers and
- iii) determine overall heat transfer co-efficient of heat exchangers

A) Theory Lecture Outlines

1. Introduction to Material Handling and Transportation-Belt conveyor, Bucket elevator, Screw conveyor, Pneumatic conveyor, Chain conveyor. Selection of material handling machines and Conveyors
2. Belt conveyor; Belt conveyor idlers, Idler spacing, Belt tension, Chain conveyor
3. Bucket Elevator: Head section, Boot section, Elevator legs, Elevator Belts, Buckets, Drive mechanism, HP requirement
4. Screw Conveyor: Screw conveyor details, various shapes of screw conveyor trough, Capacity and Horse Power
5. Pneumatic conveyor, Limitations of pneumatic conveying

6. Cleaning, Sorting and Grading
7. Peeling, Dehulling, Dehusking
8. Mixing Definition, Measurement of Mixing, Mixing index
9. Mixing Equipment- Double cone mixer, Ribbon mixer, Kneader, Propeller mixer
10. Forming-Bread moulders, Pie and biscuit formers, Confectionery moulders
11. Size Reduction and Separation-Introduction, Grinding and cutting, Energy used in grinding, Kick's law, Rittinger's law, Bond's law
12. Cutting & Grinding Equipment, Jaw crusher, Gyratory crusher, Hammer mill, Ball mill, Tumbling mill
13. Separation by Centrifugation, Filtration –Equipment and introduction
14. Separation by Expression, Extraction using solvents, Membrane concentration
15. Introduction and importance of Physical properties-Shape and size of grains, Shape and size of Fruits, Bulk density of the grains
16. True density of the grains, Porosity, Angle of repose, Test weight
17. Co-efficient of external friction, Co-efficient of internal friction, colour of food Materials
18. The need to consider hygienic design, Hazards, How to approach Hygienic design, Hygienic design Priorities, Hygienic design principles, some general design pointers (Do's & Don'ts)
19. Some Basic Concepts of Rheology, Biological systems and mechanical properties, ASTM Standard Definition of terms related to mechanical properties
20. Some Basic Concepts of Rheology, Biological systems and mechanical properties, ASTM Standard Definition of Terms related to mechanical properties
21. Other Definitions related to Mechanical Properties
22. Physical states of a material, Classical Ideal materials, Ideal elastic behavior (Hookean body), Ideal plastic behavior (St. Venant body), Ideal viscous behavior (Newtonian liquid), Rheological models, Electrical equivalence of mechanical models
23. Rheological equations, Total stress and total strain, Maxwell model, Generalized Maxwell model, Kelvin model, Generalized Kelvin model
24. Aero and Hydrodynamic Properties
25. Drag coefficient and Terminal velocity
26. Evaporation, Boiling point Elevation, Types of Evaporators, Batch Type pan evaporator, Natural circulation evaporators

27. Rising film evaporator, Falling film evaporator, Rising and Falling film evaporator, Forced - circulation evaporator, Agitated thin-film evaporator
28. Design of a single effect evaporator, Material and energy balances, Evaporator efficiency, multiple effect evaporator, Sizing of multiple effect evaporators
29. Thin layer drying, Moisture content, Equilibrium moisture content, Hysteresis, Drying curves, Constant - rate period, Falling - rate period
30. Tray and cabinet dryer, Tunnel dryer, Puff-drying, Fluidized - Bed drying, Spray drying, Freeze - Drying
31. Introduction to heat processing - Blanching, Pasteurization, Sterilization
32. Interaction of Heat Energy and Food Components - Introduction to Reaction Kinetics, Temperature Dependence of Kinetics, Thermal Destruction of microorganisms, Thermal Destruction of Enzymes, Thermal Destruction of Nutrients and quality factors

B) Practical Class Outlines

1. Determination of engineering properties of food materials
2. Study of Plate type of heat exchangers used in Dairy and Food Industry
3. Study of Shell and Tube type of heat exchangers used in Dairy and Food industry
4. Determination of thermal conductivity of milk, solid dairy and food products
5. Determination of overall heat transfer co-efficient of Shell and tube, Plate heat exchangers, Jacketed kettle used in Dairy and Food Industry - I
6. Determination of overall heat transfer co-efficient of Shell and tube, Plate heat exchangers, Jacketed kettle used in Dairy and Food Industry - II
7. Determination of overall heat transfer co-efficient of Shell and tube, Plate heat exchangers, Jacketed kettle used in Dairy and Food Industry - III
8. Studies on heat transfer through extended surfaces
9. Studies on temperature distribution and heat transfer in HTST pasteurizer
10. Design problems on heat exchangers - I
11. Design problems on heat exchangers - II
12. Design problems on heat exchangers - III
13. Determination of viscosity of different food materials
14. Design problems on heat exchangers

15. Study of evaporators and their material and enthalpy balances
16. Study of evaporators and their material and enthalpy balances

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- Mohesinin N. N. *Physical properties of Plant and Animal materials*.
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- Sahay K.M and Singh K.K. *Unit operations of Agricultural Processing*. Vikas Publishing House Pvt. Ltd. New Delhi.
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- HSE (*Health and Safety Executive*) information sheet no.24
- Singh R. P and Heldman D.R. *Introduction to Food Engineering*. 3rd Edn.,
- Smith P.G. *Introduction to Food Process Engineering*.
- Chakraverty A. *Post Harvest Technology of Cereals, Pulses and Oilseeds*. Oxford & IBH Publishers. New Delhi.
- Fennema. *Principles of Food Science*. Part II. Marcel Dekker Inc. publishers.

DEPARTMENT OF FOOD ENGINEERING

1. Course No. : FDEN - 224
2. Title : **Food Packaging**
3. Credit hours : 3 (2+1)
4. General Objectives : To impart knowledge about
 - a) The need for Optimum Packaging of foods, and
 - b) About different packaging materials, and machinery used to protect food products and increase their shelf life
5. Specific Objectives
 - a) Theory

By the end of the course, the students will be able to know

- i) about different types of paper based packaging material
 - ii) about different types of plastic based package material
 - iii) about metal and glass based packaging material
 - iv) about advanced packaging techniques and packaging machinery
- b) Practical

By the end of the Practical exercises, the students will be able to

- i) know about measurement of thickness, grammages, Burst strength of different packaging materials
- ii) know about measurement of Tensile strength, water vapour transmission rate (WVTR)
- iii) know about the pre-packing practices for packaging fruit & vegetables

A) Theory Lecture Outlines

1. Introduction to the subject, packaging situations in world and in India - Packing is pervasive and essential - Historical development of packing - 'A package must protect what it sells and sell what it protects'
2. Need of Packaging food - Logistics - Merchandising Outlets - Handling - Transportation - Packaging machinery - Technology upgradation - Public Distribution - Cost effective packaging.

3. Packaging requirements - Levels of Packaging - Packaging functions - Attractiveness - Protection - Convenience - Printability - Differentiability
4. Machinability - Environmental Impact - Low cost containment - Communication - Resealing features - Non toxicity - Aroma retention
5. Hazards acting on Package during transportation - Moisture impact - Light impact - Common insect pests - Changes in food quality - Biological changes in food quality
6. Storage - Factors influencing - Shelf Life of fruits and vegetables - Atmospheric packaging - Respiratory Metabolism
7. Controlled Atmospheric Packaging Technology (CAP) - Modified Atmospheric Packaging Technology (MAP) - Advantages of CAP and MAP - Effect of gases on MAP foods - N_2 , O_2 , CO_2
8. Labeling Laws - Packaging laws and Regulations - SWMA Rules - PFA Rules - FPO Rule - MFPO Rules - Agmark Rules - Class 'A' commodities - Class 'B' commodities - Misbranded Labeling rules for infant foods
9. National Standards on Packaging code for foodstuffs and Perishables - Classification of food stuffs according to the code - Decreasing order of their perishability - Milk and milk products
10. Fruits and vegetables - Meat, fish and poultry - Bakery rich foods - Protein rich foods - Edible starch and starch products - Oils and Fats - Food grains and food grain products - Sugar and Honey
11. Stimulant foods - Alcoholic drinks and carbonated beverages - Food Additives and Spices and Condiments.
12. Packaging materials - Classification of Packages - Paper as packaging material - Paper manufacture - Pulp - Mechanical pulp - Chemical pulping - Alkaline processes - Soda process - Sulfate process - Sulfite process - Semi chemical pulping - Digestion
13. Bleaching - Beating and Refining - Paper making - Converting - Calendering - Strength additives - Sizing agents
14. Types of paper - Kraft paper - Bleached paper - Grease proof paper - Glassine paper - Vegetable parchment Waxed paper
15. Paper Boards - Paper board grades - Folding Cartons - Kinds of carton boxes - Beverage Cartons - Molded Pulp containers - Printing and varnishing - Die cutting and creasing - Gluing and sealing

16. Glass as Package material - Composition of Glass - Basic parts of Glass container - Closures Parts of Closures - Types of Closures - Properties of glass - Internal pressure resistance - Vertical load Strength
17. Resistance to impact - Resistance to Scratches and Abrasions - Glass manufacture - Press and Blow (P&B) - Narrow Neck Press and Blow (NNPB) - Shape of glass Container
18. Improvements in glass manufacturing - Hot and Cold end treatment of surface - Inspection of Glass - Advantages and Disadvantages
19. Metal as Packaging material - Introduction - Materials used in Can Manufacture - Properties Manufacture of Tin Plate - Pig Iron - Steel making - Tin plating - Basic types of Metal Plate - Tin free steel (TFS)
20. Manufacture of ECCS- Aluminum Cans - Manufacture of Aluminium cans - Container - Advantages and Disadvantages
21. Making Processes - End Manufacture - Three Piece Can Manufacture - Welded Side seams Soldered Side seams - Double Seaming - Two Piece Can Manufacture
22. DWI Cans - DRD Cans - Protective and Decorative (Lacquers/ Enamels) - Aluminium foils and Containers - Tubes - Retort Pouch - Corrosion of Metals
23. Plastic Consumption and use in World and in India - Plastic as packaging material Classification of Plastics
24. Properties of Each Plastics - Uses and Chemistry of Polyethylene (LDPE, HDPE, LLDPE, ULDPE)
25. Polypropylene - Polystyrene - Polycarbonate - PVC - PVDC - EVOH - EVA - PVA - PET - Cellulose Acetate - Cellophane - Nylon - Plastic recycling
26. Laminations - Need of Laminations - Types of Laminations - Advantages and Disadvantages of each type - Coating on paper and films - Types of coatings - Need of Coatings - Methods of Coatings
27. Aseptic Packaging - Need for Aseptic Packaging - Materials used in Aseptic Packaging Process of Aseptic Packaging
28. Comparison of Conventional and Aseptic Packaging Aseptic Packaging System - Advantages
29. Machineries used in Food Packaging
30. Packaging of Specific Foods Like Bread, Biscuits, Coffee, Milk Powder, Egg Powder - Carbonated Beverages - Snack Foods
31. Mechanical and Functional Tests on Packaging, on Packaging boxes and on Packaging Materials - Thickness - Basic weight - Grammage

32. Water Absorption - Burst Strength - Tear Strength - Puncture- Resistance Tensile Strength - Grease Resistance - Gas Transmission Rate (GTR) - Water Vapour Transmission Rate (WVTR)

B) Practical Class Outlines

1. Classification of various packages based on material and rigidity
2. Measurement of thickness of paper, paper boards
3. Measurement of basic weight of paper and paperboards
4. Measurement of grammage and water absorption of paper, paperboards
5. Measurement of bursting strength of paper boards
6. Measurement of tear resistance of papers
7. Measurement of puncture resistance of paper and paper board
8. Measurement of tensile strength of paper boards
9. Measurement of grease resistance of papers
10. Determination of gas transmission rate of package films
11. Determination of WVTR and QTR of films
12. Determination of coating on package materials
13. Identification of plastic films
14. Finding chemical resistance of films
15. Prepackaging practices followed for packing fruits and vegetables
16. Measurement of tensile strength of plastics

References

EIRI Board of Consultants and Engineers, New Delhi, *Modern Packaging Technology*

Neelam Khetarpaul and Darshan Punia, *Food Packaging*

Richard Coles, *Food Packaging Technology*.

NIIR *Food Packaging Technology Hand Book* .

Robertson , Taylor and Francis, *Food Packaging : Principles and Practice*.

DEPARTMENT OF FOOD ENGINEERING

1. Course No. : FDEN - 321
2. Title : **Instrumentation & Process Control**
3. Credit hours : 3 (2+1)
4. General Objectives : To impart knowledge to the students on instrumentation and process controls used in food industry
5. Specific Objectives
 - a) Theory

By the end of the course the students will be able to

- i) understand the different instruments used in different operations of food industries
- ii) know about working principles of different instruments used in different operations

b) Practical

By the end of the practical exercises the student will be able to

- i) identify different instruments and controls used in various operations
- ii) identify and tackle the problems encountered in use and operation of different instruments

A) Theory Lecture Outlines

1. Introduction - measurements - methods of measurements - primary measurements - secondary measurements - tertiary measurement - instruments and measurement systems - mechanical instruments - electrical instruments - electronic instruments
2. Functional elements of measurement systems - basic functional elements - auxiliary elements - transducer elements - examples of transducer elements
3. Characteristics of transducer elements - signal conditioning elements - amplification
4. Standards of measurements - international standards - primary standards - secondary standards - working standards - calibration - classification of calibration
5. Performance characteristics - static and dynamic performance characteristics - accuracy - precession - resolution - threshold - static sensitivity - deflection factor
6. Primary sensing elements - mechanical devices as primary detectors - springs, bimetallic strips - mechanical spring devices - cantilever - helical spring - spiral spring - torsion bar - proving ring - pressure sensitive primary devices
7. Temperature and temperature scales - classification of temperature measuring devices - glass thermometers - bimetallic pressure gauge thermometers - thermocouples

8. Electrical resistance thermometers - desirable properties of liquids used in glass thermometers
9. Law of intermediate temperatures - law of intermediate metals - thermo electric sensors - thermocouples classification - base metal thermocouples - rare metal thermocouples
10. Properties of thermocouples - calibration of thermocouples - comparison method - fixed point
11. Tutorials on temperature
12. Pressure - gauge pressure, absolute pressure, differential pressure, vacuum - units of pressure - pressure scales - conversion of units
13. Measurement of pressure - mechanical pressure instruments - manometers - U tube manometer - inclined tube manometer - well type manometer
14. Elastic type pressure gauges - classification of elastic type gauges - bourdon tube - metallic diaphragm - capsule - bellows
15. Differential gauges - metallic diaphragm pressure gauge - capsule pressure gauges
16. Tutorials on pressure
17. Measurement of flow - classification of flow meters - flow of incompressible fluids in pipes - Reynolds number - discharge coefficient - flow coefficient
18. Flow of compressible fluids in pipes - orifice flow meter - types of orifice plates - materials for orifices
19. Venturi tubes - venturi construction - types of venturi tubes
20. Secondary/rate meters - variable head meters - variable area meters - types of weirs
21. Pitot static tube - its advantages - its limitations - flow meters
22. Anemometers - principle - types of hot wire anemometer - constant current type - constant temperature type - comparison between constant current and constant temperature type
23. Mechanical anemometers - types - working principle - vane anemometer - three cup anemometer - impeller anemometer
24. Liquid level measurement - various methods of level measurement by industry - level measurement using gauge glass technique
25. Gauge glass technique construction and working - its advantage and disadvantages
26. Float type level indication - float level switch - rope method
27. Float operated spring loaded switch - magnetic float device
28. Tutorials on level

29. Hydrostatic pressure measurement in open tanks - hydrostatic pressure measurement in closed tanks - hydrostatic level gauge applications
30. Data transmission elements - classification - land line type transmission elements - radio frequency type transmission elements
31. Electrical type data transmission elements - pneumatic type transmission elements
32. Position type data transmission elements - radio frequency transmission system

B) Practical Class Outlines

1. Study of instrumentation symbols
2. Measurement of temperature by different thermometers
3. Measurement of pressure by U tube manometer (inclined tube manometer)
4. Measurement of liquid level in the tank with the help of Bob and tape
5. Determination of relative humidity by wet and dry bulb thermometer
6. Measurement of velocity of fluid by using venturi meter/orifice meter/pitot tube
7. Measurement of RPM of an electric motor by tachometer
8. Measurement of wind velocity by anemometer
9. Measurement of intensity of sunshine by sunshine recorder
10. Characteristic of valve PI performance, T, P flow and level close loop control system
11. Measurement of viscosity
12. Calibration of common digital balance
13. Calibration and measurement of OD using spectrophotometer
14. Measurement of running fluid using rotameter
15. Measurement of vacuum - I
16. Measurement of vacuum - II

References

- B.C. Nakra and K.K. Chaudhary, *Instrumentation Measurement and Analysis*. Tata Mc Graw Hill, New Delhi.
- Sahney and Sahney, *A Course in Mechanical Measurement & Instrumentation*. Dhanpat Rai and Sons, New Delhi.
- K. Krishnaswamy and S. Vijayachitra, *Industrial Instrumentation*. New Age International (P) Limited, New Delhi.

DEPARTMENT OF FOOD ENGINEERING

1. Course No. : FDEN - 322
2. Title : **Food Processing Equipment - II**
3. Credit hours : 3 (2+1)
4. General Objective : To impart knowledge to the students about different food processing equipment involved in mechanical separation, clarification, filtration, membrane separation, distillation, crystallization, expression, freezing, frying, baking, irradiation, microwave heating, leaching and extraction.

5. Specific Objectives

a) Theory

By the end of the course, the students will be able to

- i) understand different food processing equipments and processes that are being used in food industries
- ii) study about the principles, operation and maintenance of food processing equipments viz., mechanical separation, clarification, filtration, membrane separation, distillation, crystallization, expression, freezing, frying, baking, irradiation, microwave heating, leaching and extraction.

b) Practical

By the end of the course, the students will be able to

- i. learn about Shelf life studies of food material
- ii. determine the Screen efficiency, distillation, equilibrium sorption isotherms (Raoult's law)
- iii. study about Freezers, Clean In Place - plant, state of water

A) Theory Lecture Outlines

1. Introduction to mechanical separation, screening, screening equipment, gyrating screens, vibrating screens
2. Mechanical separation - Gravity sedimentation, centrifugal sedimentation
3. Centrifugation : principle, equipment involved in centrifugation, liquid - solid centrifugation
4. Clarification : clarifying filters, principles of clarification, desludging and decanting machines
5. Filtration : principle involved in filtration, pressure and vacuum filtration. Cake filters, filter media
6. Filtration : filter aids, principles of cake filtration, centrifugal filters

7. Membrane separation : types of membranes and its specifications, ultra filtration, micro filtration, nano filtration, reverse osmosis
8. Dialysis : definition, principle of dialysis, electro dialysis, membranes for liquid-liquid extraction, Concentration, polarization and evaporation processes
9. Extraction : principles of extraction, extraction equipment, supercritical fluid extraction
10. Leaching : leaching equipment, principles of continuous, counter current leaching
11. Crystallization, nucleation, crystallization equipment, crystal size distribution, crystallization from melts
12. Distillation : flash distillation, continuous distillation with reflux, distillation in packed columns
13. Introduction to multi component distillation, flash distillation of multi component mixtures. Azeotropic and extractive distillation
14. Expression : batch and continuous type of expression, principles and equipment involved in expression
15. Baking : principles of baking, different types of ovens, factors affecting baking-oven parameters
16. Frying and roasting : principles, different types of equipment involved in roasting, different types of fryers
17. Shelf life : definition, calculation of shelf life, shelf life requirements
18. Shelf life : deteriorative reactions, factors affecting shelf life
19. Shelf life : simulations of product package environment interaction, Accelerated testing, transport properties of barriers
20. Shelf life simulation for moisture, oxygen and light sensitive products
21. Freezing : freezing of foods, principles, types of freezers including ice cream freezers
22. Freezing : freeze concentration and freeze drying, factors affecting freezing process and its equipment
23. Freezing : freezing curves, phase diagrams, methods of freeze concentration, design and problems
24. Raoult's law : water sorption isotherms - Hysteresis
25. Water activity measurement method, control of water activity and moisture
26. Permeability : theoretical considerations, permeability of gases and vapors
27. Permeability : permeability of multilayer materials, permeability in relation to packaging requirement of food

28. Cleaning and sanitation of food equipments and containers : can, crate, bottle washing, CIP and COP cleaning
29. Microwave heating : principle and equipment involved in microwave heating. Physical parameters and heat transfer phenomenon
30. Food processing equipment and its applications in food industry
31. Irradiation : principle and its equipment
32. Agitation and mixing of liquids : blending, mixing and pulverization equipment

B) Practical Class Outlines

1. Lab demonstration on state of water
2. Demonstration of equilibrium sorption isotherms.
3. Determination of gas transmission rate.
4. Determination of water vapor permeability of packages.
5. Evaluation of properties of films to determine their suitability as containers for foods
6. Evaluation of properties of films to determine their suitability as containers for foods
7. Evaluation of properties of films to determine their suitability as containers for foods
8. Shelf life calculations for food products
9. Material balances over screen and screen effectiveness
10. Determination of pressure drop across filter using Hermans-Breda equation.
11. Determination of area of filter medium in a continuous filtering centrifugals
12. Overall material balance for two component system in a continuous distillation plant
13. Overall material balance for two component system in a continuous distillation plant
14. Study of freezers
15. Study of CIP treatment for fruits and vegetable processing plant
16. Study of CIP treatment for Dairy - processing plant

References

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- Heldman and Singh R.P, *Food Process Engineering* AVI Pub. Co., Westport, USA.
- Arora C.P. *Refrigeration and Air conditioning*. Tata Mc Graw Hill Co, New Delhi.
- Fellows P.J. *Food Processing Technology, Principles and Practice*. Wood Head Publishing Ltd., Cambridge, England.

DEPARTMENT OF FOOD ENGINEERING

1. Course No. : FDEN - 323
2. Title : **Food Plant Design and Layout**
3. Credit hours : 3 (2+1)
4. General Objectives : To impart knowledge on food plant layout and design of food plant industries

5. Specific Objectives

a) Theory

By the end of the course, the students will

- i. acquire knowledge on theoretical aspects to be considered for site selection, layout selection and design considerations for a food plant

b) Practical

By the end of the course, the students will

- i. develop skills and acquaint in project preparations, estimations and different equipment used in various food industries

A) Theory Lecture Outlines

1. Introduction : Plant design concepts - situations giving rise to plant design problems - general design considerations - differences in design of food processing and non-food processing plants
2. Feasibility study : Steps involved including planning of the study - collection of information - information flow diagrams - market analysis, technical analysis and preparation of feasibility report
3. Plant location : Factors affecting plant location, their interaction with plant location, theory models for evaluation of alternate locations
4. Plant size : Economic plant size - factors affecting the plant size - raw materials availability, market demand, competition in the market - return on investments
5. Procedures for estimation of economic plant size - break even analysis and optimization techniques - estimation of volume of production for each product - in case of more than one product that will maximize profits
6. Process scheduling

7. Plant layout : considerations involved in planning an efficient layout
8. Types of layouts
9. Equipment symbols - flow sheet symbols - electrical symbols - graphic symbols for piping systems including pipe fitting and valves
10. Standards for space requirements - distances between critical plant areas and for setting different plant facilities
11. Development of the pilot layout : Size and structure of the pilot plant, minimum and maximum size, types and applications, pilot plant design
12. Engineering Economy : Definitions : Time value of money, inflation, Interest, Interest rate, compound interest, rate of return, payment, receipt , cash flow, present value, Equivalence, sunk costs, opportunity costs, Asset, Life of an asset, depreciation, book value of an asset, salvage value, retirement, replacement, defender and challenger.
13. Methods of economic evaluation of engineering alternatives
 1. Undiscounted cash flow methods -pay back period method
 2. Discounted cash flow methods
 - a) Net present value method
 - b) Equivalent annual method
 - c) Rate of return method

Cost- benefit analysis, Social costs, social benefits

14. Methods of economic evaluation of engineering alternatives
 1. Undiscounted cash flow methods - pay back period method
 2. Discounted cash flow methods
 - a) Net present value method
 - b) Equivalent annual method
 - c) Rate of return method

Cost - benefit analysis, Social costs, social benefits

15. Linear Programming:Introduction, Salient features of Linear programming (Terminology), Formulation of linear programming model, Advantages, limitations and applications of linear programming, solution of linear programming problems.
16. Linear Programming:Introduction, Salient features of Linear programming (Terminology), Formulation of linear programming model, Advantages, limitations and applications of linear programming, solution of linear programming problems.

17. Queuing theory : Introduction, Elements of queuing system, 1) Input source, 2) Queue and 3) Service mechanism
18. Queuing theory : Introduction, Elements of queuing system, 1) Input source, 2) Queue and 3) Service mechanism
19. Common problems in plant layout : Service system layout problem, Manufacturing layout problem, Warehouse layout problem, Nontraditional Layout problem
20. Selection of equipment : Process equipment - material handling equipment - service equipment- valves and fittings- instruments and controls- considerations involved in equipment selection
21. Selection of equipment : Process equipment - material handling equipment - service equipment- valves and fittings - instruments and controls- considerations involved in equipment selection
22. Estimation of Services and Utilities : Utilities : Fuel oil cost, Natural gas cost, electricity cost, steam cost, cooling water cost, Refrigeration cost, waste treatment cost
23. Estimation of Services such as Cafeteria, locker rooms, water closets, sinks, parking lots, exercise area,
24. Office Layout
25. Line Balancing and Line balancing techniques
26. Materials of construction of Building / structure and Equipment : Building and Structure : Foundations, supporting structure, walls, Floors, Slope of Floors, Doors, piping, Electrical, Ventilation, Hand - Cleaning - Stations.
27. Materials of construction of Equipment : Characteristics of suitable construction material : Stainless steel, Aluminum, Nickel and Monel, Plastic Materials
28. Materials of construction of Equipment : Characteristics of suitable construction material : Stainless steel, Aluminum, Nickel and Monel, Plastic Materials
29. Maintenance of Food Plant Building : Safety Color Code, Roof Inspection, Care of Concrete floors Color Coding : Color - Code System - Specific Hazards Color codes for buried pipes and cablesColor Scheme for pipes
30. Illumination and ventilation
31. Cleaning & sanitization
32. Painting and colour coding and Fly and insect control.

B) Practical Class Outlines

1. Preparation of project report
2. Preparation of feasibility report
3. Layout of Food storage wares and godowns
4. Layout and design of cold storage
5. Layout of preprocessing house
6. Layout of Milk and Milk product plants
7. Design and layout of low shelf life product plant
8. Design and layout of fruits processing plants
9. Design and layout of vegetable processing plants
10. Layout of multi product and composite food plants
11. Evaluation of given layout
12. Waste treatment and management of food plant
13. Design and layout of modern rice mill
14. Design and layout of mango pulp canning industry
15. Design and layout of spices manufacturing unit
16. Design and layout of Bakery and related product plant

References

M Moor, Mac Millan, *Plant Layout & Design*. Lames, New York.

H.S. Hall & Y.S. Rosen, *Milk Plant Layout*. FAO Pubs, Rome.

F.W. Farrall, *Dairy & Food Engineering*. John Willy & Sons, New York.

Food Plant Design by Antonio López. Gómez,

Food plant engineering systems by Theunis C. Robberts, CRC Press, Washington

Food plant economics by Zacharias B. Maroulis and George D. Saravacos published by Taylor and Francis Group, LLC

Fundamentals of Production Systems Engineering, G.S.Sekhon and A.S.Sachdev, Published by Dhanpat Rai and Company Private Limited, Delhi (Chapter NO. 19)

Operations Research by Manohar Mahajan, Published by Dhanpat Rai and Company Private Limited, Delhi

Food Process Design by Zacharias B. Maroulis published by Marcel Dekker, Inc , Cimarron Road, Monticello, New York 12701, U S A

DEPARTMENT OF FOOD CHEMISTRY AND NUTRITION

1. Course No. : FDCN - 131
2. Title : **Human Nutrition**
3. Credit hours : 2 (2+0)
4. General Objectives : To impart overall knowledge on Food, Nutrition, Nutrients to the under graduate students.
5. Specific Objectives
 - a) Theory

By the end of the course, the students will be able to

- i. give concepts of Nutrition and Food in maintaining good health and diseased conditions
- a) Practical
No practical component

A) Theory Lecture Outlines

1. Definition of various terms related to Nutrition, Food, Nutrients, Health, Good Nutrition, Malnutrition and Classification of Nutrients. Relation of Health and Nutrition
2. CHO-Classification, functions, sources, requirements for different age groups and effects of deficiency
3. Fats & Fatty acids - classification, functions, sources & requirement for different age groups and effects of deficiency
4. Proteins and Amino Acids - Classification, functions, sources requirement for different age groups and effects of deficiency
5. Energy - Definition, Units of measurement of energy, BMR, SDA of foods, factors affecting BMR and RQ
6. Balanced diets, RDA reference man and women, diets for different age groups
7. Fibre, water functions, water balance, factors affecting water balance
8. Vitamins - Classification - Vitamin A functions, food sources, requirement and effects of deficiency
9. Vitamin D function, Sources, requirement and effects of deficiency
10. Vit. E and K functions, food sources, requirement and effects of deficiency
11. Water soluble vitamins, thiamine, functions, food sources, requirements and effect of deficiency
12. Riboflavin, functions, food sources, requirements and effects of deficiency
13. Pyridoxine, Pantothenic acid, functions food sources, requirements and effects of deficiency
14. Vitamin B₁₂ & folic acid, functions, food sources, requirements and effects of deficiency

15. Ascorbic acid & Folic Acid, functions, food sources, requirements and effects of deficiency
16. Minerals, classification, General functions. Calcium and Phosphorus, functions, sources deficiency and requirements
17. Iron - distribution in the body functions, sources, absorption, deficiency and requirements
18. Sodium & Potassium - functions, sources, requirements and effects of deficiency
19. Chlorine, fluorine - functions sources, requirements and effects of deficiency
20. Zinc and Copper - functions, sources, requirements and effects of deficiency
21. Iodine, Cobalt and Magnesium - functions, sources, requirements and effects of deficiency
22. Nutrition - role of Nutrition in out come of Pregnancy and Lactation
23. Infant Nutrition - factors to be considered while planning weaning foods
24. Childhood Nutrition - Nutrition during adolescence, packed lunches
25. Role of Nutrition in old age - effect of ageing on Nutritional health of older people
26. Sports Nutrition & Space Nutrition - Significance, factors to be considered while planning diets for sports persons
27. Role of diet in disease. Dietary planning for diabetes and Kidney diseases
28. Dietary planning for heart diseases, Hypertension and Liver diseases
29. Dietary care for AIDS, Cancer patients, food allergy, care to be taken while planning diets for food allergic persons
30. Role of different organizations in maintaining health and Nutritional status. National, International agencies
31. Nutritional policies like food for work, mid-day meals, ICDS Vitamin A and Iron, Prophylaxis measures
32. Existing food fads & fallacies & How to over come

B) Practical class Outlines

No practical component

References

- Corinna H. Robinson. Fundamentals of Normal Nutrition. Mc Millan Publishing Co., New Delhi.
- Swami Nathan. Food & Nutrition, Vol. I & Vol. II. The Bangalore Printing and publishing Co. Ltd., Bangalore.
- Mahatab S. Banji, Prashad Rao. N. and Vinodini Reddy. Text book of Human Nutrition. Oxford and IBH Publishing Co. Ltd., New Delhi.
- Gordon M. Ward Law .Perspectives in Nutrition. McGraw Hill Publications, New York.
- Srilakshmi .B. Dietetics. New Age Publications, New Delhi.
- Nutritive Value of Indian Foods. NIN Publications.

DEPARTMENT OF FOOD CHEMISTRY AND NUTRITION

1. Course No. : FDCN - 132
2. Title : **Biochemistry**
3. Credit hours : 3 (2+1)
4. General Objectives : To impart knowledge to the students on the fundamentals of Biochemistry
5. Specific Objectives
 - a) Theory

By the end of the course, the students will be able to

- i. understand the concepts of Biochemistry
- ii. know the structural organization of plant cell
- iii. study the chemical properties and metabolism of biomolecules
- iv. understand the biochemical reactions occurring in plant cell

b) Practical

By the end of the practical exercises, the students will be able to

- i. have clear concepts of the structures of biomolecules
- ii. differentiate between qualitative identification and quantitative estimations, standard graph preparation
- iii. understand the separation of biomolecules using various biochemical techniques

A) Theory Lecture Outlines

1. Introduction - Importance of biochemistry - Scope of biochemistry - Historical aspects of biochemistry and branches of Bio-chemistry
2. Plant cell - Animal cell - Various organelles in plant cell and animal cell - Their functions
3. Carbohydrates - Introduction - Definition of carbohydrates, functions, classification of carbohydrates - Monosaccharides, disaccharides, polysaccharides
4. Reducing sugars - monosaccharides, glucose, fructose, disaccharides - Maltose, Lactose, Non reducing sugars - Sucrose, trehalose, inversion of sucrose
5. Polysaccharides - starch, Glycogen, Cellulose, Chitin, Insulin - Structures, functions, uses

6. Carbohydrates physical properties - Isomerism, Structural isomerism, Stereoisomerism, optical isomerism, Enantiomers, Anomers, Mutarotation, Epimers
7. Chemical properties of carbohydrates - Dehydration, oxidation, reduction, formation of esters, amination, glucoside formation, formation of osazones, cyano hydrine reaction, oximes formation
8. Amino acids - occurrence - classification - Protein and non-protein amino acids - essential and non essential amino acids - classification based on Hydrophobicity of R-side chain groups, based on the structure, based on the polarity, based on the nutritional and metabolic rate
9. Chemical properties of amino acids - Ninhydrin - peptide bond reaction - decarboxylation - Schiff base formation - Transamination - oxidative and non - oxidative deamination - sangers reagent - Edmans reagent - Dansyl chloride test
10. Peptides and their functions - Oligo peptides, cyclic and acyclic peptides - Malformin, Glutathione, and Gramicidin, Hormones, Insulin
11. Structure of proteins - primary, secondary, tertiary and quaternary structure and forces involved in the stabilizing proteins
12. Classification of proteins - based on solubility, function, properties of proteins - U.V.absorption Denaturation, Renaturations and immune reaction
13. Purification techniques of proteins - salting in, salting out, Gel filtration, Ion exchange chromatography
14. Enzymes - characteristics of enzymes, chemical nature, specificity, active site and mechanism of action - Lock and key model, Induced fit model
15. Measurement of enzymatic activity, factors affecting enzymes activity
16. Enzymatic inhibitions, Iso enzymes, co-enzymes, halo enzymes, prosthetic group classification and Nomenclature of enzymes
17. Lipids - occurrence - Classification, functions and structures of saturated and unsaturated fatty acids, importance of essential fatty acids
18. Chemical properties of fatty acids Rancidity, saponification, Iodine number, Reichart Meissel number, acid value
19. Nucleic acids - functions, structure of Nitrogen bases, Nucleosides and Nucleotides - ATP, GTP, CTP, UTP, TTP, Secondary structure of DNA
20. Various types of DNA and RNA

21. Metabolism - Anabolism - Catabolism - stages of respiration, overall metabolic view of carbohydrate, protein and lipids
22. Glycolysis and its energetics
23. TCA cycle and its energetics
24. Gluconeogenesis.
25. Glycogen metabolism - Glycogenesis, Glycogenolysis
26. Hexose mono phosphate pathway
27. Metabolism of lipids - Anabolism of saturated fatty acids , unsaturated fatty acid
28. Catabolism of lipids - Triacyl glycerols and ω - oxidation of fatty acids in brief and β - oxidation in detail
29. Vitamins - occurrence, chemistry and structure of vitamins
30. Metabolic functions of fat
31. Bio chemical functions of vitamins
32. Biochemical functions of Minerals

b) Practical Class Outlines

1. Safety measures in the laboratory
2. Preparation of standard acid, and alkali solutions
3. Qualitative test for all carbohydrates - Solubility, Molisch, Anthrone, Iodine test
4. Qualitative test for Pentoses, reducing sugars, (Bials,Fehlings, Benedicts, Barfoeds test)
5. Qualitative test for Glucose, Fructose, Sucrose (Osazone, Acid hydrolysis, Selewanooffs.)
6. Quantitative test for all Amino acids, aromatic amino acids, Sulphur containing amino acids (Ninhydrin, Xantho proteic, Nitro Prusside test)
7. Quantitative tests for peptide bonds and proteins (Biuret test & Folin - Lowry test)
8. Precipitation of proteins with heavy metals, acidic reagents, organic solvents, salting out of proteins.
9. Qualitative test for lipids - Solubility test ,Translucency test, Emulsification test, litmus and Saponification test
10. Test for glycerol and Test for cholesterol
11. Qualitative tests for RNA (Orcinol test, Phosphate test)

12. Qualitative tests for DNA (Diphenylamine test, phosphate test)
13. Isolation of RNA from Plant sample
14. Separation of Amino Acids by paper chromatography
15. Verification of Beer's law using colorimeter
16. Preparation of standard graph

References

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- Conn, E.E., Stumpf, P.K., Bruening, G. and Doi, R.H. 1995. *Outlines of Biochemistry*. John Wiley and Sons Inc., Singapore.
- Jayaraman, J. 1980. *Laboratory Manual in Biochemistry*. Wiley Eastern Publishers, New Delhi.
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- Plummer, D.T. 1979. *An introduction to Practical Biochemistry*. Tata McGraw-Hill Publishing Co., New Delhi.
- Rameshwar, A. 2006. *Practical Biochemistry*. Kalyani Publishers, Ludhiana.
- Sadasivam, S. and Manickam, A. 1996. *Biochemical methods for Agricultural Sciences*. New Age International Publisher, New Delhi
- Stryer, L. 2005. *Biochemistry*. W.H. Freeman and Company, New York.
- Voet, D. and Voet, J.G. 2004. *Biochemistry*. John Wiley and Sons Inc., USA.

DEPARTMENT OF FOOD CHEMISTRY AND NUTRITION

1. Course No. : FDCN - 231
2. Title : **Food Chemistry of Macronutrients**
3. Credit hours : 3 (2+1)
4. General Objectives : To impart knowledge to the students on the chemistry of macronutrients and its application in food industry. To understand different chemical and enzymatic chemical reactions occurring in foods
5. Specific Objectives
 - a) Theory

By the end of the course, the students will be able

- i. to gain knowledge on different chemical & enzymatic reactions occurring in foods
- ii. understand Industrial application of different macronutrients
- iii. apply their knowledge of biomolecules to understand the changes that occur in foods during processing.

b) Practical

By the end of the course, the students will be able to

- i. quantitatively estimate different macronutrients in foods

A) Theory Lecture Outlines

1. Food chemistry - Definition, Introduction, Importance and History of Food Chemistry
2. Moisture in foods - Role and type of water in foods
3. Water activity and sorption isotherm - Role of water activity in enhancing the shelf life of foods - Hysteresis - Humectants - Role of Humectants in enhancing the shelf life of foods
4. Dispersed systems of foods - Colloidal system - Types of colloidal system
5. Sols - Types of sols, lyophilic sols, lyophobic sols, Preparation, purification and Properties of sols
6. Gels-Types of Gels, properties of gels, Food gels
7. Emulsions - Types of emulsions, Preparation and properties of emulsions
8. Foam - Formation and structure

9. Changes of carbohydrates on cooking - Changes in pectic substances, Changes in starch
10. Reactions involved in food processing
11. Starch - Starch granules, Granule gelatinization (Gelatinization of starch), Hydrolysis of starch, Crude fibre
12. Browning reactions - Enzymatic browning and nonenzymatic browning
13. Functional properties of sugars
14. Pure proteins of plant and animal origin with their functional characteristics
15. Plant proteins - cereal proteins, tuber proteins and pulse storage proteins
16. Milk proteins - Casein, whey proteins and colostrums
17. Egg proteins - Egg white proteins, Egg yolk proteins
18. Lipids - Introduction - Fatty acids, Acylglycerols, Phospholipids
19. Classification of edible fats - Milk fats, lauric acids, vegetable butters, oleic-Linoleic acids, linolenic acids, Animal fats, Marine oils
20. Physical aspects of lipids - Crystallization, Consistency
21. Chemical aspects of lipids - Lipolysis, Auto-oxidation, Thermal decomposition, polymerization
22. Edible fats and oils - Melting properties, chemical properties
23. Technology of edible fats and oils - Rendering, pressing, solvent extraction
24. Chemistry of fat and oil processing : Refining, Hydrogenation, Interesterification
25. Frying technology of edible fats and oils - Chemistry of frying, Behaviour of frying oil
26. Behaviour of food during frying, chemical and physical changes, Tests for assessing the quality of frying oils
27. Anti-oxidants-Natural and synthetic anti oxidants, Mechanism of action, examples and mode of application
28. Rancidity and its types, detection techniques
29. Enzymes in food industry - Carbohydrases-Amylases, pectinolytic enzymes, cellulases and hemicellulases
30. Proteases - Endopeptidases, Metallo peptidases
31. Lipid hydrolyzing enzymes - Lipases, Phospholipases
32. Chemical reactions of interest to food processing

B) Practical Class Outlines

1. Determination of moisture content in foods.
2. Determination of total carbohydrate content in foods
3. Determination of total carbohydrate content in foods
4. Determination of reducing sugars in foods
5. Determination of enzymatic and non-enzymatic browning in foods
6. Determination of enzymatic and non-enzymatic browning in foods
7. Determination of protein in foods by kjeldhal method
8. Determination of protein in foods by folin – Lowry method
9. Determination of lipid content in foods by soxhlet apparatus
10. Determination of methionine in foods
11. Determination of selected amino acids in foods
12. Determination of Tryptophan
13. Determination of selected amino acids in foods (methionine,lysine)
14. Determination of emino acids in foods trypthophan total free aminoacid
15. Determination of free fatty acids in foods.
16. Determination of saponification value of foods.

References

HD. Belitz, Dr.W.Grasch 1987, *Food Chemistry* – Spirigerverl, Newyork.

Fenema O.R. Maraceladikllor, *Food Chemistry* – London.

Food Chemistry - Meyer.

Harry H. Sisler, Calvin: A.Vander Werf. *Food Chemistry*

N.A. Michael Eskin *Biochemistry of Foods* 2nd edition.

DEPARTMENT OF FOOD CHEMISTRY AND NUTRITION

1. Course No. : FDCN - 232
2. Title : **Food Chemistry of Micronutrients**
3. Credit hours : 3 (2+1)
4. General Objectives : To impart knowledge to the students on the chemistry of micronutrients and its application in food industry
5. Specific Objectives
 - a) Theory

By the end of the course, the students will be able to understand

- i. role of micronutrients in imparting flavor, taste and color
- ii. biochemical mechanism behind flavor production and perception, color
- i. different chemical and enzymatic reactions occurring in foods
- ii. industrial application of different micronutrients

b) Practical

By the end of the course, the students will be able to

- i. quantitatively estimate different micronutrients in foods

A) Theory Lecture Outlines

1. Introduction - Definition of Micronutrient, Classification of Micronutrients, Significance and Scope
2. Flavor - Definition, Methods for Flavor Analysis, Taste and Nonspecific Saporous Sensations, Taste Substances; Sweet, Bitter, Sour, and Salty sensations, Structural basis of taste modalities, Non specific Saporous substances; Flavour Enhancers, Astringency, Pungency and Cooling
3. Flavors related to Spices - Sulfur Containing volatiles in Allium sp. - Sulfur Containing volatiles in Cruciferae
4. Flavors related to vegetables - Methoxy Alkyl Pyrazine Volatiles in Vegetables - Volatiles derived from Fatty Acids by enzymatic action -Volatile from Branched Chain Amino Acids
5. Flavors related to fruits - Flavors derived from the Shikimic Acid Pathway - Volatile Terpenoids - Citrus Flavors -Flavors of Herbs

6. Flavor volatiles - from Lactic acid, ethanol fermentation, fats and oils, Muscle foods and Milk
7. Pigments - Introduction - Pigments in animal and plant tissue - heme compounds, Chlorophyll, carotenoids, Flavonoids and other phenols, Betalains.
8. Heme compounds - Myoglobin/hemoglobin, Structure of heme compounds
9. Myoglobin - Chemistry and color, Cured Meat pigments, stability of Meat pigments
10. Chlorophyll - Structure and derivatives of chlorophyll - Physical characteristics
11. Alterations of Chlorophyll by Enzymatic - Heat and Acid - Metallo complex formation - Allomerization - Photodegradation
12. Loss of green color during thermal processing - different technologies of green colour preservation - Acid neutralization to retain chlorophyll, High Temperature Short Time Processing, Enzymatic conversion to chlorophyllides, Commercial application of metallo complex, Regreening of thermal processing.
13. Carotenoids - Structures of Carotenoids - Occurance and distribution - Physical properties
14. Chemical properties of carotenoids - Oxidation, Anti oxidative activity, Cis/Trans Isomerization – Stability during processing
15. Flavonoids and other phenols - Anthocyanins - Structure - Color and Stability of Anthocyanins
16. Factors affecting stability of Anthocyanins - Structural transformation and pH - Temperature - oxygen and Ascorbic acid - Light, Sugars and their degradation products, metals, Sulfur dioxide, Co pigmentation, Enzyme reactions
17. Other flavonoids - physical properties - Importance in foods - Proanthocyanidins - Tannins - Quinoids and xanthones
18. Betalaines - Structure - Physical properties - Chemical properties - Conversion of Betacyanin to Betaxanthin
19. Food colorants - Regulatory aspects - Properties of certified dyes - use of certified dyes - Colors exempt from certification
20. Vitamins - Introduction, Toxicity of vitamins - Different sources of vitamins - Dietary recommendations
21. Bioavailability of vitamins - General causes of variation/ losses of vitamins in foods.
22. Fat soluble vitamins - Water soluble vitamins - Vitamin like compounds - Optimization of vitamin retention - enrichment - restorations - fortification

23. Minerals - Introduction - Principles of mineral chemistry - Nutritional aspects of minerals - Essential mineral elements - Recommended Dietary allowances - Bioavailability
24. Minerals composition of foods - Ash - Fortification - Effect of processing - enrichment - restorations - Losses of minerals, Optimization and retention of Minerals in foods
25. Chemical and functional properties of minerals in foods
26. Thickeners and Stabilizers in foods - Chemical composition of Acacia gum, Agar, Alginic acid, Carrageenan, guar gum, Specific function and utilization in foods
27. Thickeners and Stabilizers in foods - Hydroxy propyl methyl cellulose, Locust Bean gum, Methyl cellulose, Pectin, Sodium carboxy methyl cellulose, Tragacanth gum - Specific function and utilization in foods
28. Antinutritional factors in foods - Saponin, Phytic acid, hemagglutinins or lectins
29. Modification of food using enzymes
30. Role of endogenous enzymes in food quality - color - Texture - Flavor and aroma changes in foods - Nutritional quality
31. Enzymes as processing aids and ingredients - Biocatalytic production of sweeteners - Enzymes in Milk and Dairy products, for modifying lipids, for production of desirable effects, for removal of unwanted constituents
32. Enzymes in Baking - Brewing

b) Practical Class Outlines

1. Preparation of mineral solution by using ash and tri acid method (Dry and wet oxidations)
2. Estimation of calcium in foods.
3. Estimation of Phosphorous
4. Estimation of Iron
5. Estimation of Magnesium
6. Estimation of Tannins
7. Estimation of phenols
8. Estimation of Vitamin A
9. Estimation of β -Carotene
10. Estimation of Thiamine
11. Estimation of Riboflavin

12. Determination of Lycopene
13. Determination of Chlorophyll
14. Determination of Anthocyanins
15. Determination of Phytic acid
16. Determination of Ascorbic acid by dye method

References

Dr. Ling HD. Belity, Dr. Ing, W.Grach 1987, *Food Chemistry* - Spirigerverl, New York.

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R. Marceladikllor, *Food Chemistry* - Fenema, London.

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Braverman *Introduction to the Biochemistry of Foods* - Elsevier Scientific Publishing Company

Sadasisivam - *Biochemical Methods*

DEPARTMENT OF FOOD CHEMISTRY & NUTRITION

1. Course No. : FDCN - 331
2. Title : **Techniques in Food Analysis**
3. Credit hours : 3 (1+2)
4. General Objectives : To impart knowledge to the students on the Techniques in food analysis
5. Specific Objectives : To ready them with the Analytical techniques in Quality control laboratory.

a) Theory

By the end of the course, the students will be able to

- i) understand the concepts of Techniques in food analysis,
- ii) understand proximate analysis of foods
- iii) understand Biochemical methods and approaches used in Food analysis

b) Practical

By the end of the practical exercises, the students will be able to

- i. adapt suitable method for food analysis
- ii. apply the knowledge of Techniques in Food Analysis,
- iii. differentiate between Qualitative identification and Quantitative estimations
- iv. understand the separation of biomolecules using various biochemical techniques

A) Theory Lecture Outlines

1. Introduction to the chemical analysis of food - Definitions of food analysis, Quality control, Official methods of analysis. Association of Official Analytical Chemists, American Association of Cereal Chemists, American Oil Chemists Society
2. Rules and Regulations of Food Analysis
3. Nutritional Labelling , Food Inspection and Grading, food safety - Safety rules in the chemistry
- Safety rules - What to do in case of an accident - Broken Glass - Small chemical spill - Large chemical spill - Chemical splash in your face - Large splash of dangerous chemical on your clothing and or body, small confined fire, small open fire, large fire, your clothing on fire

4. First Aid -Thermal burns, chemical burns, minor bleeding, toxic fumes, fainting and shock, chemical splashes
5. Sampling and Sampling Techniques - Introduction - Definitions of Population, Laboratory Sample, sample, precision, accuracy, sensitivity, Reproducibility - of Analysis - Official Samples, Raw Materials
6. Basic principles of spectrophotometer and colorimeter and its application
7. Analysis of Carbohydrates - Introduction - Importance of Carbohydrate Analysis - Methods of Analysis - Sample preparation - Extraction of Monosaccharides, Oligo saccharides
8. Chemical methods for carbohydrates - Gravimetric methods - Titrimetric methods - Colorimetric methods - phenol sulfuric acid - Enzymatic methods
9. Physical methods - Polarimetric method, Refractive index measurements, Density, Infrared radiation, Immuno assays
10. Analysis of starch and crude fibre
11. Analysis of proteins - Introduction - Importance of protein analysis - Determination of overall protein concentration by Kjeldhal method, Enhanced Dumas method, using U.V.Visible spectroscopy. Direct measurement at 280 nm, Biuret method, Lowry method, Dye binding method, Turbido metric method
12. proteinand characterisation - Basic principles of chromatography - types of chromatography and its applications
13. Analysis of lipids - Introduction - Importance of analysis of lipids - Determination of total lipid concentration - solvent extraction
14. Extraction of lipids - solvent, Non solvent extraction methods, instrumentation methods
15. Determination of lipid composition - Separation and analysis by chromatography - lipids fractions of TLC - Fatty acid methyl esters by GC - Chemical techniques - acid value, instrumental techniques of analyzing lipid oxidation in foods - Chromatography, peroxide value - Characteristics of physico chemical properties
16. Analysis of minerals - Introduction - Importance of mineral analysis - Dry ashing - Wet ashing - Low plasma ashing, Adsorption spectroscopy

B) Practical Class Outlines

- 1 Introduction to Food Analysis Techniques
- 2 Preparation of solutions

- 3 Preparation of Buffers
4. Preparation of standard graph
5. Sampling techniques and methods of sample preparation
6. Colorimetry and spectrophotometry
7. Determination of pH of Food samples (milk, flours, jams)
8. Determination of Titratable acidity
9. Determination of Moisture and Total solids
10. Estimation of carbohydrates by Phenol Sulphuric Acid method
11. Estimation of Fructose by Roes method
12. Estimation of starch
13. Analysis of crude fibre
14. Analysis of crude fibre
15. Proteins analysis, separation, characterization - I
16. Proteins analysis, separation, characterization - II
17. Proteins analysis, separation, characterization - III
18. Estimation of free Fatty acids in plant oils
19. Estimation of free Fatty acids in animal oils
20. Estimation of Cholesterol
21. Estimation of Vitamin C by using Colorimetric method
22. Estimation of Vitamin - D
23. Estimation of DNA
24. Estimation of RNA
25. Analysis of minerals in plant samples
26. Analysis of minerals in animal samples
27. Analysis of pesticides in food samples
28. Analysis of pesticide residues in milk
29. Test for adulterants in Sugar, Jaggery, Honey
30. Test for adulterants in Milk, Ghee

31. Test for adulterants in plantation crops(Tea, coffee) and Turmic

32 Test for adulterants in spices(Cardamom, cloves, pepper)

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Sadasivam, S. and Manickam, A. 1996. *Biochemical methods for Agricultural Sciences*. New Age International Publisher, New Delhi.

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DEPARTMENT OF FOOD AND INDUSTRIAL MICROBIOLOGY

1. Course No. : FDIM - 141
2. Title : **Fundamentals of Microbiology**
3. Credit hours : 3 (2+1)
4. General Objectives : To study Microbiology as a basic science. To impart the basic concept of Microbiology.
5. Specific Objectives
 - a) Theory

By the end of the course, the students will be able to

- i. know about different types of micro organisms that invade food
- ii. get knowledge about pathogenic organisms
- iii. impart knowledge about metabolic activities of micro organisms (Bacteria and fungi)
- iv. know about microbial culture media and their applications and preservation

b) Practical

By the end of the practicals exercises, the students will be able to

- i. get the Knowledge of handling the microscope
- ii. know about cultivation of different types of bacteria
- iii. know how to differentiate types of bacteria and fungi
- iv. know about the preservation and maintenance of bacteria
- v. know about handling the Autoclave and sterilization procedure

A) Theory Lecture Outlines

1. Evolution and scope of microbiology. Haeckel's Kingdom protista. Prokaryotic and Eukaryotic organisms. Whittaker's five kingdom concept. Kingdom prokaryote after bergey's manual of systematic bacteriology
2. History of Microbiology. Spontaneous generation vs. biogenesis. Contributions of different scientists to the microbiology. Germ theory of Diseases
3. Microbial classification, nomenclature and identification. Taxonomic groups. General methods of classifying bacteria
4. Microscopy and microscopes : Bright field microscopy resolving power, numerical aperture, limit of resolution. Magnification, dark field microscopy

5. Fluorescent antibody technique. Immuno fluorescence phase contrast microscopy, electron microscope. Smears and staining
6. Morphology and fine structure of bacteria. Size, shape and arrangement of bacterial cells. Bacterial structures - flagella and motility, pili, capsules, sheaths, prosthecae and stalks
7. Cellwall, Cytoplasmic membrane, protoplasts, spheroplasts, mesosomes, cytoplasm, Ribosomes, cytoplasmic inclusions and vacuoles, nuclear material, endospores and cysts.
8. Cultivation of Bacteria, Nutritional requirements. Nutritional classification of bacteria. Phototrophs, chemotrophs, autotrophs and heterotrophs. Obligate parasites
9. Bacteriological media, types of media, physical conditions required for growth
10. Growth of bacteria, normal growth cycle (growth curve) of bacteria. Transitional periods between growth phases. Synchronous growth. Continuous Culture
11. Quantitative measurement of bacterial growth. Direct microscopic count. Electronic enumeration of cell numbers. Plate count method, membrane filter count
12. Turbidimetric methods. Determination of Nitrogen content. Determination of dry weight of cells
13. Reproduction of bacteria, binary fission, budding. Distinguishing characteristics of fungi, morphology of fungi. Asexual reproduction of fungi and sexual reproduction of fungi. Cultivation of fungi
14. Yeasts - Morphological characteristics. Reproduction cultural characteristics. Algae - Morphology, reproduction and rickettsia, Protozoa - Morphology and reproduction of protozoa
15. Nutrient transport phenomenon. Passive diffusion, facilitated diffusion. Group translocation, active transport
16. Microbial genetics. Bacterial recombination. Bacterial conjugation, transduction. Bacterial transformation. Regulation and expression of gene activity. (Lac operon)
17. Mutations. Types of mutations, mutagenesis, mutation rate - repair of mutations, Phenotypes of bacterial mutants. Designation of bacterial mutants
18. Destruction of microorganisms. Physical agents - High temperature, thermal death time and decimal reduction time, application of high temperatures for destruction of microorganisms
19. Destruction of microorganisms - low temperatures, dessication, osmotic pressure, radiation, U.V. light, x-rays, gamma rays, cathode rays, bacteriological filters
20. Control of micro organisms by chemical agents. Characteristics of an ideal antimicrobial chemical agent. Phenol and phenolic compounds, lactose

21. Alcohols, Halogens, Heavy metals and their compounds, dyes, synthetic detergents, quaternary ammonium compounds, aldehydes, Gases as Agents
22. Control of microorganisms by antibiotics. Chemotherapeutic agents and chemotherapy. Characteristics of antibiotics
23. Mode of Action of Antibiotics. Antifungal, antibiotics, antiviral chemo-therapeutic agents. Anti tumor antibiotics, synthetic chemotherapeutic agents
24. Energy production: Oxidation and reduction reactions. Energy production by anaerobic processes (Glycolysis, pentose phosphate pathway, Entner - Doudoroff Pathway, Fermentation)
25. Energy production by aerobic processes : TCA cycle, energy yield in aerobic respiration
26. Catabolism of lipids, catabolism of proteins. Respiration without oxygen in some bacteria. Heterotrophic CO₂ fixation. Glyoxylate cycle
27. Energy production by photosynthesis. Cyclic and non cyclic photo phosphorylation. Mechanism of ATP synthesis
28. Viruses - Discovery and significance. General characteristics. Morphology and structure (Morphological groups of phages)
29. Phage structure, phage nucleic acids. Replication of bacterial viruses
30. Lysogeny, Food borne viruses (Polio, hepatitis, gastroenteritis viruses)
31. Pure culture : methods of isolation of pure cultures
32. Maintenance and preservation of pure cultures. Culture collections

B) Practical Class Outlines

1. Experiment on Microscopy
2. Experiment on Micrometry
3. Cleaning & Sterilization of glassware
4. Preparation of nutrient agar media and techniques of inoculation
5. Staining methods - Study on monochrome staining
6. Study on Negative staining
7. Study on Capsule staining
8. Study on Flagella staining
9. Study on Endospore staining

10. Pure culture techniques (Streak plate / pour plate)
11. Introduction to identification procedures (morphology and Cultural)
12. Growth characteristics of bacteria : Determination of microbial numbers, direct plate count, generation time
13. Growth characteristics of bacteria : Determination of microbial numbers, direct plate count, generation time
14. Factors influencing growth : pH, temperature, growth curves of bacteria
15. Methods of microbial culture preservation for bacteria & yeasts
16. Anaerobic culture methods

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- C.B. Power and H.F. Dagainawala, *General Microbiology*, Himalaya Publishing House, Bombay.
- Ronald M Atlas, 1995, *Principles of Microbiology* 1st Edition, Mosby Year Book Inc., St. Louis Missouri.
- David White, 1995, *The physiology and Biochemistry of Prokaryotes*, Oxford Univ. Press, U.K.

DEPARTMENT OF FOOD AND INDUSTRIAL MICROBIOLOGY

1. Course No. : FDIM - 142
2. Title : **Food Microbiology**
3. Credit hours : 3 (2+1)
4. General Objectives :
 - a) To impart the knowledge about micro organisms associated with foods
 - b) To know the sources, contamination and spoilage of micro organisms
 - c) To study the preservation of food for future use and to familiarize the students with principles and preservation of food

5. Specific Objectives

a) Theory

By the end of the course, the students will be able to

- i. know about Contamination of Foods
- ii. know about the food spoilage organisms
- iii. know about food preservation techniques
- iv. know about different micro organisms that invade different foods

b) Practical

By the end of the practical exercises, the students will be able to

- i. know how to isolate micro organisms from different foods
- ii. know about micro organisms count by aerobic colony count (ACC) and Most Probable Number (MPN)
- iii. know about microbial destruction methods

A) Theory Lecture Outlines

1. Microbial spoilage of foods. Cause of spoilage classification of foods by ease of spoilage. Factors affecting kinds and numbers of microorganisms in food
2. Factors affecting growth and survival of microorganisms in foods. Intrinsic factors - Nutrient content, pH, buffering capacity, redo potential (En), Inhibitory substances and biological structures (Antimicrobial barriers and constituents) water activity

3. Extrinsic factors - Relative Humidity, Temperature, Gaseous Atmosphere. Chemical changes caused by microorganisms - changes in nitrogenous organic compounds, non-nitrogenous organic compounds, organic acids, other compounds, Lipids, Pectic substances
4. Contamination of Foods. Sources of contamination. Green plants and Fruits, Animals, Sewage, Soil, Water, Air
5. Microorganisms importance in Food Microbiology. Moulds - General characteristics of moulds, classification and identification of moulds
6. Yeasts and Yeast like fungi - General characteristics of yeasts, classification and identification of yeasts, yeasts of industrial importance
7. Bacteria - Morphological characteristics important in Food Bacteriology. Cultural and Physiological characteristics important in food bacteriology. Genera of bacteria important in Food Bacteriology groups of bacteria important in food bacteriology
8. Principles of Food Preservation. Methods of Food preservation, application in food preservation
9. Asepsis, removal of Micro organisms. Maintenance of Anaerobic conditions
10. Food Preservation by use of high temperature. Factors affecting heat resistance (Thermal death time). Heat resistance of Microorganisms and their spores
11. Determination of heat resistance. Heat penetration - Pasteurization, Heating at about 100°C. Heating above 100°C, canning. [Note : Determination of Thermal processes, Methods TDT curves will be dealt in practicals]
12. Preservation by use of low temperatures. Growth microorganisms at low temperatures. Common or Cellar storage. Chilling or cold storage. Freezing or Frozen storage. Sharp Freezing and quick freezing. Changes during freezing, storage and thawing
13. Preservation by drying, methods of drying. Treatments of foods before drying. Procedure after drying. Microbiology of dried foods. Intermediate moisture foods
14. Preservation by food additives - The ideal antimicrobial preservatives. Organic acids and their salts, nitrites and nitrates, sulfur dioxide and sulfites. Ethylene and propylene oxide, sugar and salt
15. Preservation by Food Additives - Alcohol, formaldehyde, wood smoke, spices and other condiments and other additives. Other groupings of chemical agents, antibiotics, developed preservatives
16. Food Preservation by Radiation - U.V. Radiation, ionizing radiations, definition of terms, x-rays, gamma rays and cathode rays, Microwave processing. High pressure processing, pascalization

17. Microbiology of milk and milk products. Contamination, preservation, pasteurization and ultra pasteurization, vat pasteurization. Vapourization, use of low temperatures, freezing, drying etc
18. Spoilage of milk and cream, gas production proteolysis, ropiness, changes in milk fat. Alkali production. Flavor changes & colour changes
19. Spoilage of milk at different temperatures. Condensed and dry milk products. Flavour defects, color defects
20. Microbiology of fruits and vegetables, contamination, preservation of vegetables, asepsis, chilling, freezing, drying, preservatives, CA storage, MA storage. Spoilage of fruits and vegetables
21. Microbiology of cereal and cereal products contamination, preservation and spoilage of flours
22. Microbiology of cereal and cereal products. Spoilage-Bread, Mold, Rope, Red bread, Chaky Bread
23. Microbiology of Meat and Meat Products. Contamination, preservation.
24. Spoilage of meat and meat products. Invasion of tissues by microorganisms and growth of microorganisms in meat
25. General types of spoilage of meats. Spoilage under anaerobic conditions, spoilage of different kinds of meats
26. Microbiology of fish and other sea foods. Contamination, preservation, spoilage
27. Factors influencing kind and rate of spoilage, evidences of spoilage, bacteria causing spoilage
28. Microbiology of poultry and eggs. Contamination, preservation, spoilage. Changes during storage. Changes not caused by microorganisms and changes caused by microorganisms
29. Microbiology of sugar and sugar products. Sources of contamination, spoilage and Prevention
30. Microbiology of salts and spices, sources of contamination, spoilage and prevention, fatty foods and rancidity
31. Microbiology of canned foods. Causes of spoilage, appearance of the unopened container, types of biological spoilage of canned foods. Flat sour spoilage, TA spoilage, sulfide spoilage
32. Types of spoilage of canned foods by bacteria, yeasts, molds. Spoilage of canned meat and fish

B) Practical Class Outlines

1. Isolation of molds from foods
2. Microbial examination of cereal and cereal Products – Identification, Isolation - I
3. Microbial examination of cereal and cereal Products – Identification, Isolation - II
4. Microbial examination of vegetable and fruits – Identification, Isolation - I
5. Microbial examination of vegetable and fruits – Identification, Isolation - II
6. Microbial examination of meat and meat products – Identification, Isolation - I
7. Microbial examination of meat and meat products – Identification, Isolation - II
8. Microbial examination of fish and other sea foods – Identification, Isolation - I
9. Microbial examination of fish and other sea foods – Identification, Isolation - II
10. Microbial examination of Eggs and poultry – Identification, Isolation - I
11. Microbial examination of Eggs and poultry – Identification, Isolation - II
12. Microbial examination of milk and milk products – Identification, Isolation - I
13. Microbial examination of milk and milk products – Identification, Isolation - II
14. Microbial examination of sugar, salts and spices – Identification, Isolation - I
15. Microbial examination of sugar, salts and spices – Identification, Isolation - II
16. Thermal Death Time determination

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- Adam M R and Moss M.O., *Food Microbiology*, New Age International (P) Ltd., Publishers, New Delhi.
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- Carlvan Derzant and Splitsoessev, *Methods for Microbial Examination of Foods*, APHA Publishers, Washington DC, USA.

DEPARTMENT OF FOOD AND INDUSTRIAL MICROBIOLOGY

1. Course No. : FDIM - 241
2. Title : **Fermentation and Industrial Microbiology**
3. Credit hours : 3 (2+1)
4. General Objectives : To impart the knowledge to students about
 - a) Fermentation technology and its application in Food industry
 - b) Industrially important Microorganisms and their application in food industry

5. Specific Objectives

a) Theory

By the end of the course, the students will be able to

- i) know about Industrial fermentation techniques
- ii) know about different Industrially important micro organisms
- iii) know about different growth regulators (Hormones)
- iv) know about different products produced by Industrial fermentation process

b) Practical

By the end of the practical exercises, the students will be able to

- i) know about production and isolation of Biocolours, β carotene
- ii) know about Assay of antibiotics and amino acids
- iii) perform production of Industrially important products
- iv) know the production and Assay of enzymes

A) Theory Lecture Outlines

1. Microbes as friend's - Normal flora - History of Industrial Microbiology, Microbes influencing our lives - Primary metabolites & secondary metabolites produced by the microorganisms.
2. Screening of Microorganisms - Primary screening - Isolation of desired and interested microorganisms - Secondary screening - yield potential of microbes - both qualitative and quantitative approach
3. Strain Improvement - Preservation of Microorganisms - Organizations involved in microbiological work

4. Fermentation media - Characteristics of an ideal production medium, Raw materials as media, Precursors and Inducers, Repressors, Antifoams.
5. Industrial sterilization - Principles of Sterilization - Sterilization of equipment, Sterilization of Production media and sterilization of air.
6. Types of fermentors - Stirred tank fermentors - Packed bed fermentors - Fluidized bed fermentors - Bubble column fermentor - Air lift fermentor - Cylindrical fermentors - Flocculated cell culture fermentor - Multi phase bioreactors - Trickling bed bioreactors - Tubular fermentor- Mechanically agitated stirred tank reactors, Deep jet fermentor, Cyclone Column Fermentor, Novel See saw Bioreactor, Stirred tank fermentor (CSTF).
7. Fermentor - Components of a Fermentor, Parts of Fermentors, Peripheral parts and accessories, Alternative Vessel Designs, Additional accessories and Peripherals, Feed pumps, Exit gas analysis, Common measurements and Control systems (Speed Control, Temperature control, Control of Gas Supply, Control of pH, Control of Oxygen)
8. Types of fermentations - Solid Substrate Fermentation-Submerged Fermentation - Factors affecting Submerged culture - Batch fermentation - Fed batch fermentation - Sub batch fermentation - Continuous fermentation - Multiple fermentations - Multistage fermentations.
9. Industrially important secondary metabolites - Production of Organic acids - Citric acid, Lactic acid, Itaconic acid, Acetic acid, Gluconic acid, Kojic acid, Gallic acid - Production - Microorganisms & Metabolisms - Fermentation conditions - Inoculum preparation - Carbon and nitrogen source - Trace elements - pH and temperature - Aeration and Agitation. Yield and Recovery. Uses of organic acids
10. Production of Antibiotics - Screening of antibiotic producers - β - lactam antibiotics - Penicillin - Amino glycoside antibiotics - Tetracyclines, Chloramphenicol, Griseofulvin, Macrolide antibiotics, Rifamycins. Streptomycin - Chemical nature and biosynthesis - Commercial production - Inoculum - Media - Fermentation process - Temperature - Aeration - pH - Biomass production - Recovery and purification - uses of antibiotics
11. Probiotics – Importance – role in fermented dairy foods - Yoghurt - *Lactobacillus acidophilus* - *Bifidobacterium* - *Lactobacillus delbrueckii* - *Lactobacillus bulgaricus* - Standard number of Probiotics to be used - Probiotic cheese - *Lactobacillus salivarius* - *Bifido bacterium* bifidum - Kefir - combination of Lactic acid bacteria and yeasts- therapeutic and medicinal value - enhances digestion.
12. Bacteriocins - Nisin - Production - metabolism - Fermentation conditions - Inoculum preparation - carbon and nitrogen source - Trace elements - pH and temperature requirement - Recovery and purification

13. Biocolours - carotenoids - lycopene - Angkak- production - using fungi - *Monascus purpureus* - History and traditional uses - Morphology - Fermentation conditions - Pigment of *M. purpureus* - Health benefits - Toxicology - Safe consumption
14. Plant growth regulators and Hormones - Role in metabolic activity of plants - Microorganisms involved in the production of Auxins, Gibberellins, Cytokinins, purification. Role of Ethylene and abscissic acid in plant metabolic activity
15. Production of Microbial enzymes - Solid state fermentation - Fermentors - Medium - Advantages and disadvantages - Submerged fermentation - Steps of enzyme production - Factors affecting submerged culture. Production of Amylases, proteases, Pectinases, Cellulases
16. Extraction of enzymes - physical disruption method - Chemical treatment method - Purification of enzyme - removal of nucleic acids and cell debris - preliminary purification - Final purification - Applications
17. Downstream processing - Steps involved in the purification of biological - Capture intermediate - Polishing - Cell disruption methods - Chemical methods - Mechanical methods - Sonication - Freeze - thawing - Concussion device - Liquid shear - Colloid mill - French press
18. Centrifugation - Flocculation and coagulation - Filtration - Product concentration- Extraction - Chromatography - Size exclusion - Ion exchange - Affinity - Hydrophobic interaction - Immobilized metal ion affinity chromatography - HPLC - Gas chromatography - Supercritical fluid chromatography - Electrophoresis - Mass spectrometry
19. Microbial polysaccharides - Bacterial polysaccharides - Localization and description - Xanthan - Pullan - Curdlan - Exopolysaccharides from lactic acid bacteria - dextran - from extremophilic bacteria
20. Fungal polysaccharides - cell wall polysaccharides - Lichen cell wall polysaccharides - fungal exopolysaccharides - Production of polysaccharides - Culture techniques and fermentation parameters - Agitation - pH - Aeration - culture medium - immobilized micro organisms - Solid state fermentation
21. Applications of polysaccharides - Polysaccharides as food additives - Pharmaceutical applications - Oligosaccharides derivatives
22. Production of amino acids – Historical developments - Manufacturing methods - Extractive isolation - Chemical synthesis - Enzymatic catalysis - Fermentative production - L - Glutamic acid - L- Lysine - uses and applications
23. Production of vitamins - General aspects - Nomenclature and classification - Vitamin B complex - Vitamin B₁₂ - Vitamin B₂ - production of these vitamins - production by fermentation of *Ashbya gossypii* - Vitamin C

24. Production of bio insecticides - *Bacillus thuringiensis* - insecticidal protein - endotoxin - engineering with endotoxin gene - rDNA technology - inserting into maize - cotton - rice - BT cotton
25. Production of SCP - Single cell protein advantages - Source of SCP - Production of bacterial biomass - Production using waste - Starchy waste - from Algae - Nutritive value of SCP - Consumption of SCP - uses of SCP
26. Bakers yeast - Development and history - The Vienna process - Production of yeast - Nutrient materials - Concentration of sugar - Aeration - temperature - pH - Molasses ammonia process - yeast from sulphite liquor - Florylin yeast - Food and fodder yeast - yeast products - fat from yeast - vitamins from yeast
27. Batch fermentation - Fed batch fermentation - Sub batch fermentation - Continuous fermentation - Multiple fermentations - Multistage fermentations
28. Food based fermented products - Cheese - Types, ripening of cheese - Yogurt - Buttermilk - Acidophilus milk - Cream - Fermented vegetables - Sauerkraut - pickles - Silage - Kimchi
29. Olives - Fermented meat - fish - Bread and other fermented plant products - fermented cereal foods. Wine, production and Beer production and Mushroom production
30. Biochemical changes - fermented legumes foods - Bhallae - Papadam - vada - Fermented cereal legume foods. Fermented dairy foods - Yoghurt - *Lactobacillus acidophilus* - *Bifidobacterium* - *Lactobacillus delbrueckii* - *Lactobacillus bulgaricus* - Standard number of probiotics to be used - probiotic cheese
31. Industrial fermentors - Accessories - Types of fermentors - Stirred tank fermentors - Packed bed fermentors - Fluidized bed fermentors - Bubble column fermentor - Air lift fermentor - Cylindrical fermentors - Flocculated cell culture fermentor - Multi phase bioreactors - Trickling bed bioreactors
32. Blue green algae - general characters - occurrence - Industrial importance of Blue green algae - uses of Blue green algae.

B) Practical Class Outlines

1. Standardization of physical factors for higher yields of citric acid
2. Production and assay of antibiotics
3. Isolation, identification of cultures producing biocolours
4. Production and assay of carotenes
5. Production of Beer
6. Production of Angkak (Red rice)

7. Estimation of colouring compounds
8. Production and assay of fungal amylase
9. Production and assay of fungal proteases
10. Production of Xanthan or Pullan
11. Production and assay of amino acids
12. Production of Beer
13. Production and assay of nisin from lactic acid bacteria
14. Production of Single cell protein
15. Bakers yeast effect in Bread preparation
16. Preparation of food based fermented product

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DEPARTMENT OF FOOD AND INDUSTRIAL MICROBIOLOGY

1. Course No. : FDIM - 242
2. Title : **Food Safety and Microbial Standards**
3. Credit hours : 3 (2+1)
4. General Objectives : To impart the knowledge to students about
 - a) Food safety and microbial standards
 - b) Various toxins both natural and synthetic used in food processing
 - c) Sanitation principles
5. Specific Objectives
 - a) Theory

By the end of the course, the students will be able to

- i) understand about toxins from bacteria and fungi
- ii) know about different food additives, anti nutrients, anti vitamins used in food processing
- iii) understand about heavy metal contamination in foods
- iv) understand about food safety and microbial standardization

b) Practical

By the end of the practical exercises, the students will be able to

- i) know about isolation of toxins from different food materials
- ii) know about detection of heavy metals from plant and animal source
- iii) know about risk assessment and management determination
- iv) know about national and international microbial quality standards

A) Theory Lecture Outlines

1. History of Food spoilage, Food poisoning, Food legislation and Food preservation. Dietary toxins - Food poisoning, Intoxication, Infection, Classification of toxins
2. Food borne bacterial toxins - *Clostridium botulinum*, *Clostridium perfringens*, *Staphylococcus* - Types of food involved - toxicity and symptoms - Chemical properties - Environmental conditions
3. Food borne bacterial toxins - *Salmonella*, *Vibrio*, *Escherichia coli*, five groups of *E.coli*, *Bacillus cereus*. Types of food involved - toxicity and symptoms - Chemical properties - Environmental conditions

4. Food borne bacterial toxins - *Listeria*, *Shigella*, *Yersinia*, *Campylobacter*, *Aeromonas*, *Brucella*, *Pleisiomonas*. Types of food involved - toxicity and symptoms - Chemical properties - Environmental conditions
5. Mycotoxins - Types of mycotoxins - Aflatoxins, Patulin, Penicillic acid, Ochratoxin, citrinin, Alternaria toxin - Types of food involved - toxicity and symptoms - Chemical properties - Environmental conditions
6. Mycotoxins - Sterigmatocystin, Fuminosins, Sambutoxin, Zeralenone, Ergotism, Cyclopiazonic acid, Rubratoxin, Satratoxin, Verrucaric acid, and Roridin, Tricothecenes, Roquefortine - Types of food involved - toxicity and symptoms - Chemical properties - Environmental conditions
7. Mushroom toxins, Different spp of poisonous mushrooms, Poisoning or disorders due to poisonous mushrooms. Control of mycotoxins in food and feed
8. Algal toxins - Paralytic shell fish poisoning, Ciguatera poisoning, Domoic acid, Tetrodotoxin, cyanobacterial toxins, Scombroid Fish poisoning, *Pfiesteria piscicida* - Types of food involved - toxicity and symptoms - Chemical properties - Environmental conditions
9. Food borne animal parasites - Protozoans - Giardiasis, Amebiasis, Toxoplasmosis, Sarcocystis, Cryptosporidiosis, Cyclosporiasis - Types of food involved - toxicity and symptoms - Chemical properties - Environmental conditions
10. Food borne animal parasites - Flat worms - Fascioliasis, Fasciolopsiasis, Paragonimiasis, Clonorchiasis, Diphyllorhynchiasis, Taeniasis, Round worms (Trichinosis, Anisakiasis) - Types of food involved - toxicity and symptoms - Chemical properties - Environmental conditions
11. Food borne viruses - Polio, Hepatitis A and E, Noroviruses, rota viruses, Prion Diseases - Types of food involved - toxicity and symptoms - Chemical properties - Environmental conditions
12. Metals as toxins - Heavy metals - Arsenic - Occurrence - detection in foods - Toxicological effects - limits - Cadmium - Occurrence - detection in foods - Toxicological effects - limits - Mercury - Occurrence - detection in foods - Toxicological effects - limits
13. Lead, Tin, Zinc, Aluminium, Chromium, Cobalt, Antimony - Occurrence - detection in foods - Toxicological effects - limits
14. Pesticides - Chlorinated pesticides and non chlorinated pesticides - Decontamination of food commodities of their insecticide residues. Movement of Residues in the environment
15. Pesticides - Mechanisms of Toxicity - Residues in Food, Acceptable daily intakes, Maximum residue limits.
16. Antinutrients - Toxic phenolic substances, Flavonoids, tannins, Coumarin - Toxicity and symptoms - Chemical properties (structure and stability) - Type of foods involved - Prevention

17. Antinutrients - Saffrole, Myristicin, Cyanogenic glycosides, Glucosinolates, Allylthiocyanates, favism, Lathyrism, Canavanine, Acetylcholinesterase inhibitors, Goitrogens, Caffeic acid & chlorogenic acid, Glycoalkaloids, Saponins
18. Anti nutritive factors -Type A antinutritives - antiproteins- Protease inhibitors - Lectins - Type B antinutritives - antiminerals - Phytic acid - Oxalic acid - Glucosinolates - Diterpene fiber - Gossypol - Type C antinutritives - anti vitamins - Ascorbic acid oxidase - Antithiamine factors - Antipyridoxine factors
19. Anti microbial agents - common anti microbial food agents - Benzoic acid - Benzoates - Sorbic acid - Sorbates - Short chain organic acids - acetic acid - lactic acid - propionic acid - citric acid - parabens - sulfite - nitrite
20. Anti microbial agents - Natural antimicrobial substances present in foods (Indirect antimicrobials) - Antioxidants, Flavoring agents, spices and essential Oils, phosphates, Medium chain fatty acids and esters, acetic and lactic acid
21. Anti microbial agents - Antibiotics(Monensin, natamycin, tetracyclins, Subtilin, Tylosin, Nisin, Endolysins), Antifungal agents for fruits, Ethylene and propylene Oxides
22. Antimicrobial agents - Miscellaneous chemical preservatives - Chitosans, Dimethyl dicarbonate, Ethanol, Glucose oxidase, Polyamino acids. Bacteriophages as biocontrol agents, hurdle concept
23. Sanitation - GMPs - Personal hygiene - Sanitizers - Sanitation principles - Sanitizing methods - Sanitation agents - Chlorocompounds- Iodocompounds - Bromocompounds - Acid and alkali compounds
24. Sanitation - Ozone, hydrogen peroxide, Activated Lactoferrin and Acidified sodium chlorite - Factors influencing efficacy of sanitizers
25. Food safety-Indicators of food microbial Quality and safety - Coliforms, Enterococci, Bifidobacteria, Coliphages/Enteroviruses, predictive Microbiology/ Microbial modeling
26. Risk assessment and management during food preparation - HACCP - prerequisite programmes, definitions, HACCP principles, Flow diagrams, Application of HACCP principles, Limitations of HACCP
27. Risk assessment and management during food preparation - Food safety Objective (FSO), Microbiological criteria, definitions, sampling plans
28. Microbiological criteria for various food products - Sea foods, Milk products, Spices, Fruits and vegetables
29. Food laws & Standards - FAO, Codex Alimentarius, ISO, Indian food laws and standards, Prevention of Food adulteration (PFA)act, Fruit Products Order(FPO), Meat product order (MPO), Cold storage order (CSO),BIS, Agmark
30. Non permitted food additives - Allura red AC, Aspartame, amaranth, Benzoic acid, brilliant black, Butylated Hydroxy - anisole, Calcium benzoate, Calcium sulphite

31. Non permitted food additives- Monosodium glutamate (MSG) Ponceau 4R, Conchineal Red A, Potassium benzoate, Potassium nitrate, Propyl p-hydroxybenzoate, propylparaben, and paraben
32. Non permitted food additives - Saccharin & its Na, K and Ca salts, Sodium metabisulphite, Sodium sulphite, Stannous chloride (tin), Sulphur dioxide, Sunset Yellow FCF, Orange Yellow S, tartrazine

B) Practical Class Outlines

1. Estimation of bacterial toxins from food sample - I
2. Estimation of bacterial toxins from food sample - II
3. Estimation of bacterial toxins from food sample - III
4. Estimation of bacterial toxins from food sample - IV
5. Estimation of fungal toxins from food sample - I
6. Estimation of fungal toxins from food sample - II
7. Estimation of fungal toxins from food sample - III
8. Estimation of fungal toxins from food sample - IV
9. Detection of heavy metal from plant source
10. Detection of heavy metal from animal source - I
11. Detection of heavy metal from animal source - II
12. Risk assessment
13. Management determination
14. Study of National microbial quality standards
15. Study of International microbial quality standards
16. Visit to export oriented food industry

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Wisconsin- Madison 1995, *Food Safety*, Food Research Institute University.

N.G Marriott (1985), *Principles of Food Sanitation*, AVI Pub. Co. USA.

PS Diamond and R.F Denmen *Laboratory techniques in chemistry and biochemistry*.

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DEPARTMENT OF FOOD AND INDUSTRIAL MICROBIOLOGY

1. Course No. : FDIM - 341
2. Title : **Food Biotechnology**
3. Credit hours : 3 (2+1)
4. General Objectives : To impart the knowledge to students about
 - a) Prospectus of Biotechnology
 - b) Application of Biotechnology in food industry and Agriculture
5. Specific Objectives
 - a) Theory

By the end of the course, the students will be able to

- i) get knowledge about basics and fundamentals of Molecular biology
 - ii) know about rDNA Technology and their applications in different areas
 - iii) know about cell and tissue culturing techniques
 - iv) know about application of biotechnology in particular to food industries
- b) Practical

By the end of the practical exercises, the students will be able to

- i) know about different techniques used in rDNA technology
- ii) know about Strain improvement and production of biomass
- iii) know about isolation of DNA from different sources

A) Theory Lecture Outlines

1. Prospectus of Biotechnology-new development in the science of gene manipulation - a rash of new companies - to commercialize the new technology - Human genome sequencing project - potential for human therapy - Regulation of transcription of particular genes - making easy to use cloning kits - recombinant DNA technology in all biological disciplines
2. Molecular genetics - chromosomes - genome - genes - Chromonemata - nucleosomes - Heterochromatin - Organization of chromosomes - nature of gene - definitions of gene - classical - modern - gene as unit of - physiological function - transmission - mutation - Cistron - Recon - Muton - Number of genes - functions of genes

3. Fundamentals of molecular biology - DNA as genetic material - Hershey and chase experiment - RNA as genetic material - Viruses and bacteriophages - Genetic material organization - Transcription - Translation
4. Chemistry and biology of DNA - Structural elements of nucleic acids - sugar - Anionic group - Nitrogenous bases - Purines - pyrimidine's - Nucleosides - Nucleotides - Phosphoric acid - ATP - GTP - CTP - UTP - TTP - Functions of nucleotides - chemical energy carriers - building blocks of nucleic acids - Physiological messengers - Components of coenzymes - enzymes effectors- Active substrates
5. Primary conformation of DNA - Secondary conformation of DNA - Watson and Crick model -Types of DNA- A, B, Z - Tertiary conformation of DNA - Higher level of chromatin structure - Denaturation and renaturation -Types of RNA - mRNA- rRNA- tRNA - sRNA - hn RNA - functions-ScRNAs - Sn RNAs
6. Biological role of DNA in cell - control of metabolic activity of cell - maintainance and regulation of cell activity - DNA replication - semiconservative model - The Meselson stahl experiment
7. Requiriments for DNA synthesis - Substrate - Primer - proteins - DNA polymerase - I, II, III - Helicase - Topoisomerase - primase - ligase - ssb proteins - Mechanism of replication - Initiation - elongation - termination
8. Genetic recombination - Gene transfer mechanism - Conjugation - Process - F plasmid - Hfr factor - Transformation - Competence - Gram positive transformation - Gram negative transformation
9. Micro injection - calcium chloride mediated - calcium phosphate mediated - electroporation - Particle bombardment method- Transduction - Generalized transduction - Co-transduction - Abortive transduction - Specialized transduction
10. Strain Improvement - Importance of pure culture - Isolation and purification of pure cultures - Alteration of genes by mutation - induced mutation - Frame shift mutations
11. Chromosomal mutation - Additions - Deletions - use of rDNA technology of alter the genes - better yield of metabolites - primary metabolites - secondary metabolites
12. Industrial fermentation process - Fermentor - design and construction - Fermentation media - Physical properties of media - Types of fermentors - Stirred tank fermentors - Packed bed fermentors - Fluidized bed fermentors - Bubble column fermentor - Air lift fermentor - Cylindrical fermentors - Flocculated cell culture fermentor - Multi phase bioreactors - Trickling bed bioreactors

13. Types of fermentations - Batch fermentation - Feed batch fermentation - Sub batch fermentation - Continuous fermentation - Multiple fermentations - Multistage fermentations
14. Regulation of gene expression - Induction- repression - LAC operon- The operon model - promoter - operator- Structural genes - Lac Z gene - Lac Y gene - Lac A gene - regulation of lac operon - negative regulation - positive regulation
15. Gene Manipulation tools - Different enzymes used - Helicases - premases - topoisomerases - RNA polymerase I,II, - Holoenzyme - sigma factor - DNA Gyrase - DNA polymerase - I, II, III
16. Restriction enzymes - restriction endonucleases - Nomenclature of enzymes - three letter code - Molecular scissors - nature of cutting ends - Blunt ends - Sticky ends - Isoschizomers - Recognition sites - Star activity - neoisoschizomers - Cleavage - mechanism of action - uses of restriction enzymes
17. Recombinant DNA technology - Selection of DNA - Selection of suitable vehicle - cloning vector - Selection of suitable enzyme - Introduction of rDNA - Screening of host cells - selection based on antibiotic resistance - complementation of nutritional defects - assay of biological activity - immunochemical method- colony hybridization - Expression of target gene in the host cell
18. Plasmids - occurrence - extra chromosomal DNA - cloning vectors - Plasmids as vectors - Bacteriophages - Lambda phage vector - Bacteriophage M13 vectors - Cosmids as vectors - Eukaryotes as vectors - Plant viruses - pBR322 - Insertion vector- Replacement vector - Shuttle vectors - Phasmids - Artificial chromosomes - Bacterial artificial - yeast artificial (YAC)
19. Gene cloning- Production of identical cells - Isolation and purification of insert DNA - Isolation of vector DNA - Construction of recombinant DNA - Introduction of recombinant DNA into host cell - Identification and selection of cells containing cloned genes
20. Cell and Tissue culture- Animal cell culture- primary cell lines - secondary cell lines - Minimal essential medium - Amino acid assay medium - plant cell culture- Plasticity - Totipotency - MS medium - microproagation - callus formation - Organ development - tissue transformation - uses of tissue culture
21. Expression of foreign genes - Transformation - calcium chloride mediated - calcium phosphate mediated - microinjection - liposome mediated gene transfer - electrophoration
22. Selection of cells containing cloned genes - selection based on antibiotic resistance - complementation of nutritional defects - assay of biological activity - immunochemical method - colony hybridization - Expression of target gene in the host cell - Shot gun method- DNA libraries - Genomic DNA libraries - cDNA libraries - Protoplast transformation

23. Biomass production- recycling of waste - Sewage - Domestic - Agricultural - Industrial - Treated sewage for single cell protein production - Single cell protein advantages - Source of SCP - Production of bacterial biomass - Production using waste - Starchy waste - from Algae - Nutritive value of SCP - Consumption of SCP - uses of SCP
24. Energy production methods - methanogens - incarnation - biofuel - Bioremediation - Bioventing - Land farming - Bio augmentation - use of spent mushroom compost
25. Biosensors - classification - Field of application - Transducers - Electrochemical biosensors - Voltammetric - Potentiometric - Conductometric - chemical sensitive field effect transistors (CHEMFET)
26. Optical biosensors- Biological components - Method of immobilization - Pressure biosensors - Thermo metric biosensors- Glucose biosensors - Glycerol biosensors - Ethanol biosensors
27. Enzyme technology - Microbial enzymes - production of enzymes - Solid state fermentation - Fermentors - Medium - Advantages and disadvantages - Submerged fermentation- Steps of enzyme production - Factors affecting Submerged culture
28. Immobilization of enzymes - Arresting of cell in insoluble matrix - Immobilized cell systems - cell attachment to a surface - Aggregation - Entrapment - Containment - Physical adsorption - Covalent binding - Cross linking - Entrapment into polymeric films - Microencapsulation - Large scale cell immobilization - uses and applications in industries
29. Application of Biotechnology in food - building up of high biological value protein - Nucleic acid sequences as diagnostic tools - Protein engineering - Vitamin production - Amino acid production - Antibiotic production - Biopolymers
30. Application of Biotechnology in Pharmaceuticals - Identification of disease causing genes - Production of Hormones - Vaccines - Interferon - Regulatory proteins - antibiotics
31. Application of Biotechnology in Agriculture - Improvement of nutritional quality - post harvest technology - Changing plants at their genetic level - To develop nitrogen fixation - Production of disease resistant plants
32. Bio gas plant - Anaerobic digestion - Methane formation - Methanogenic fermentations - Methane oxidation - Hydrocarbon degradation - Anaerobic digester designs - positive and negative features of anaerobic process

B) Practical Class Outlines

1. Study of auxotroph
2. Micropropagation through tissue culture
3. Strain improvement

4. Strain improvement through U.V. mutation for lactose utilization
5. Chemical mutagenesis using chemical mutagens (Ethylm bromide)
6. Determination of survival curves using physical mutagens
7. Determination of survival curves using chemical mutagens
8. Isolation and analysis of chromosomal / genomic DNA from *E.coli*
9. Isolation and analysis of chromosomal / genomic DNA from *Bacillus cereus*
10. Separation of protoplasts
11. Separation of protoplasts using cellulytic enzymes
12. Production of biomass from fruit waste
13. Production of biomass from vegetable waste
14. Introduction of ELISA / Southern blot / DNA finger printing
15. Agarose gel electrophoresis of plasmid DNA
16. Pesticide degradation by *pseudomonas spp*

References

Sandy Primrose, Richard Twyman, Bob Old, *Principles of Gene Manipulation* sixth Edition

T.A Brown, *Gene Cloning*

Agrawal / Parihar, *Industrial Microbiology - Fundamentals and Applications*

B.D Singh, *Text Book of Biotechnology*

AshokPandey, Christian Larroche, *Advances in Fermentation Technology*

DEPARTMENT OF FOOD TRADE AND BUSINESS MANAGEMENT

1. Course No. : FTBM - 151
2. Title : **Principles of Economics**
3. Credit hours : 2 (2+0)
4. General Objectives : To impart knowledge to the students on the fundamentals of micro and macro economics
5. Specific Objectives
 - a) Theory

By the end of the course, the students will be able

- i. gain knowledge on consumers behaviour, demand and supply of the commodities, different types of markets, different types of business organization, concepts and measurements of national income, inflation and public revenue
- a) Practical

No practical component

A) Theory Lecture Outlines

1. Economics - meaning, definitions, nature, scope and subject matter of economics
2. Traditional and modern approach of economics
3. Nature of micro and macro economics
4. Basic terms and concepts - Goods and services, classification of goods
5. Utility - meaning, characteristics of utility and forms of utility
6. Price - meaning; wealth - attributes of wealth, types of wealth, distinction between wealth and welfare
7. Wants - meaning, characteristics of human wants and classification of wants
8. Demand - meaning, individual and aggregate demand schedule, individual and aggregate demand curves, types of demand-price demand, income demand, cross demand. Factors affecting demand
9. Law of demand - Contraction and extension in demand, increase and decrease in demand
10. Elasticity of demand - Types of Elasticity of demand - degrees of elasticity of demand and practical importance of elasticity of demand

11. Stock, Supply - meaning, difference between stock and supply, supply schedule, supply curve, types of supply- factors influencing supply
12. Law of supply - Extension, contraction and increase and decrease in supply
13. Elasticity of supply-degrees of elasticity of supply-factors influencing elasticity of Supply
14. Consumers surplus –meaning, importance, assumptions, explanation of the consumers surplus with table and diagram, difficulties in measuring consumers surplus
15. Conditions of perfect and imperfect markets, characteristics of perfect and imperfect Competition
16. Classification of imperfect competition-monopolistic-oligopoly- duopoly- monopoly-monopsony, bilateral monopoly
17. Price determination under perfect market situations
18. Law of diminishing marginal utility- law, assumptions, importance, explanation and limitations of the law
19. Law of Equi-marginal utility-meaning, assumptions of law, importance, explanation and limitations of the law
20. Nature and scope of Agricultural Economics, its role and importance
21. Characteristics of factors of production, measures to improve land productivity, Government Policies
22. Labour – division of Labour - meaning, forms of division of labour, problems of unemployment, under employment and disguised unemployment
23. Capital meaning, Characteristics of capital, fixed and working capital, capital formation meaning three stages in capital formation, factors affecting capital formation
24. Forms of business organizations-individual enterprises or individual proprietorship, partnership, joint stock company their advantages and disadvantages
25. Forms of business organizations - Co-operative enterprises and public enterprises and their advantages and disadvantages
26. Market – definition, functions, essentials of markets, classification of markets based on different criteria
27. National income-concepts
28. National income - measurements

29. Inflation –meaning, classification, types of inflation
30. Inflation –Causes of inflation and remedial Measures
31. Public Revenue/Tax- meaning, cannons of taxation, kinds of taxes, direct and indirect Taxes
32. Characteristics features of developed and under developed economies

B) Practical class Outlines

No practical component

References

- Dewett K.K. and Verma J.D. 1986, *Elementary Economic Theory* - S.Chand & Co., New Delhi.
- Jain P.C. 1960, *A Text Book of Modern Economics* - Allahabad Chaitanya Publishing House, Allahabad.
- Ruddor Dutt, K.P.M.Sundaram 1996, *Indian Economy* - S. Chand & Co., New Delhi.
- Mishra S.K. and Puri V.K. 1996, *Indian Economy* - Himalaya Publishing house, New Delhi.
- Subba Reddy S. , Raghu Ram, Neelakanta Sasthri and Bhavani Devi, 2009. *Agricultural Economics*. Oxford and IBH publishing Co.Pvt. Ltd., New Delhi.

DEPARTMENT OF FOOD TRADE AND BUSINESS MANAGEMENT

1. Course No. : FTBM - 251
2. Title : **Business Management and International Trade**
3. Credit hours : 3 (3+0)
4. General Objectives : To impart knowledge to the students on Management of Food Industry & International Trade
5. Specific Objectives
 - a) Theory

By the end of the course, the students will be able to

- i. gain knowledge on resource management, capital management, food industry management, international trade, GATT, WTO, Government institutions related to international trade, Agencies of international trade
- a) Practical

No practical component

A) Theory Lecture Outlines

1. Business - meaning - characteristics of business - divisions of business - industry - commerce
2. Theories of Management
3. Functions of management - Planning - nature of planning - importance of planning - kinds of enterprise plans - planning premises - forecasting - steps in forecasting
4. Organization - Meaning - importance - features of all organization structures - views of organization - process of organization - principles of organization.
5. Staffing and directing - nature of direction - principles of direction- communication - Motivation.
6. Controlling - nature of controlling- requirements of good control system
7. Co-ordination - features of co-ordination-techniques of co-ordination.
8. Fixed capital - factors determining fixed capital requirements - sources of fixed capital - working capital - gross and net classification-determinants and sources
9. Human resource development - man power planning - manpower utilization - current man power assessment - future man power demand - employment trends

10. Career planning - elements of career planning - criteria in developing career planning-organization plans for career planning.
11. Learning process - principles of learning - training - importance of training - values of training - training needs - elements of training.
12. Training methods and techniques - on the job training - vestibule training - class room training - apprentices training- induction training - procedure for training - elements of training.
13. Materials management - meaning - scope - material control - purchase management- functions of purchase department.
14. Objectives of purchase department- steps in purchasing - store keeping - objectives and functions of store keeping.
15. Marketing Management - Definition - Meaning - Importance - Marketing mix - 4Ps of Marketing - Product - Place - Price - Promotion - 4 c's of marketing mix
16. Different Process of Marketing- Market Segmentation - Methods of market Segmentation - Target marketing - Market Penetration- Market positioning
17. Product life cycle - Introduction stage - Growth - Maturity - Saturation - Decline - why Products fail - Extending the life cycle of a product.
18. Personnel Management - importance - objectives - scope of Personal Management
19. Sectors in food Industry
20. Scale of operations of food industry in India
21. Scale of operations of food industry in India
22. International Trade - Definition - Basis for International Trade - Distinction between Home trade and foreign trade
23. Advantages and Disadvantages of International Trade
24. Principles of International trade - Classical theory - theory of absolute advantage - Theory of comparative costs
25. Modern theory of International Trade
26. Free trade Vs protection - Methods of protection - Quotas, bounties, exchange control, De-valuation - commercial treaties
27. Terms of trade - Balance of Trade - Balance of payments, Introduction, Current and Capital accounts
28. Terms of trade - Equilibrium - Dis-equilibrium in balance of payments - Methods of Correcting dis-equilibrium

29. EXIM policy - Commodity agreements
30. Foreign exchange - Introduction - mode of foreign payments - Exchange rate Determination - Under Gold Standard
31. Theories of Exchange rate determination – the Purchasing Power Parity (PPP) theory
32. Modern theory of exchange rate determination
33. Achievements of GATT - International Economic organization - GATT – Brief history of GATT
34. GATT rounds – Achievements of GATT
35. WTO – Functions of WTO – Objectives of WTO – Structure of WTO – Scope of WTO
36. Role of WTO in International Trade - Difference between WTO and GATT - Superiority of the WTO over the GATT
37. United Nations conference on trade and development (UNCTAD)
38. European Economic Community (EEC)
39. Trade related aspects intellectual property rights – Trade mark – Trade secret – Patents – Industrial Designs – Copy rights etc.
40. World trade agreements related with food business – International buffer stocks – Export quotas – Multilateral trade agreements – Price compensation Agreements
41. Export trends & prospects of food products in India
42. World consumption of food – Patterns and types of food consumption across the globe – Ethnic food habits of different regions
43. Government institutions related to international food trade - APEDA, Tea board
44. Government institutions related to international food trade - APEDA, Tea board
45. Management of export import organization – Registration – Documentation
46. Agencies of International Trade ECM, EFTA 1959, LAFTA, CACM, UNCTAD
47. Export Import Logistics – Case Studies
48. Export & import policies relevant to horticultural sector

A) Practical class Outlines

No practical component

References

- Dewett K.K. and Varma J.D. , *Elementary Economic Theory*.
- Dewett K.K. and Chand S. , *Modern Economic Theory*.
- Paul R.R., *Money, Banking and International Trade*.
- Vaish and Sudama Singh M.C. , *International Economics*.
- Prabhakara Rao J.V. and Ranganathachari R.V. , *International Business*.
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- Ahuja K.K. 1998 *Personal management*.
- Rajan Sexena 1998 *Marketing management*.
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- Gupta R.S., Sharma B.D. and Bhalla N.S. (1999) *Principles and Practices of Management*.
- Mirza S Saiyadain 2006 *Human Resource Management*.
- Bhushan Y.K. 2008 *Fundamentals of Business Organization and Management*.
- Mohini Sethi 2008 *Institutional Food Management*.
- Seetharaman S. and Venkateswara Prasad B. 2009 *Human Resource Management*.
- Narayanappa G.L. 2009 *Human Resource Management*.

DEPARTMENT OF FOOD TRADE AND BUSINESS MANAGEMENT

1. Course No. : FTBM - 351
2. Title : **IT Applications in Food Industry**
3. Credit Hours : 2(1+1)
4. General Objectives : Able to know about “The necessity of Software & their applications in Food Industries” & Able to Implement the Programs in ‘C’ to perform various operations that are related to Food Industries

5. Specific Objectives

a) Theory

By the end of the course, the students will be able to

- i. know about the various steps which are related to computer and Software and their application in Food Industries
- ii. know about the various steps which are necessary to implement the programs in ‘C’

b) Practical

By the end of the course, the students will be able to

- i. know about “How to perform the various operations which are related to Food Industries in Microsoft Office Tools (Ex: MS-Excel, MS-Power Point...etc..)
- ii. know about “How to build the program to perform various mathematical, logical Operations in ‘C’ which are related to Food Industry.

A) Theory Lecture Outlines

1. Computerization, Importance of Computerization in food industry and IT applications in food industries
2. Computer operating environments and information system for various types of food industries. Introduction to Barcharts and Piecharts & the procedure to develop barcharts and piecharts on given Data
3. Introduction to Software & Programming Languages, Properties, Differences of an Algorithm and Flowcharts, Advantages and disadvantages of Flowcharts & Algorithms
4. Introduction, Fundamentals & advantages of ‘C’
5. Steps in learning ‘C’ (Character set, Identifiers, Keywords) Steps in learning ‘C’ (Data types, Constants, Variables, Escape sequences)

6. Steps in learning 'C' (Operators, Statements) Steps in learning 'C' (Header Files, Input & Output functions: Formatted I/O functions, Unformatted I/O functions)
7. Basic Structure of a simple 'C' program
8. Decision Making/Control Statements
9. Branching, Concept of Looping & Looping statements
10. Concept of Functions (Defining a function & Function Prototypes, Types of functions: Library functions & User defined functions)
11. Concept of various types of User Defined Functions(i.e., About 4 types)
12. Concept of Arrays & Types of Arrays(Single, Double and Multi dimensional Arrays)
13. Concept of a String Library Functions
14. Concept of Pointers, Structures & Unions
15. Introduction to Data Structures, Types of Data Structures (Primary & Secondary Data Structures) Concept of Linked Lists, Types of Linked Lists & Basic operations on linked Lists.
16. Concept of Stacks & Operations on Stacks (PUSH & POP Operations) Concept of Queues and types of Queues Operations on a Queue (ENQUEUE & DEQUEUE Operations)

B) Practical Class Outlines

1. Application of MS Excel to solve the problems of food technology, Introduction to C compiler & How to handle the C compiler (Controllers used in C Compiler)
2. Statistical quality controls of food, Developing and executing simple C programs (By using various operators used in 'C').
3. Sensory Evaluation of food, Developing and executing simple 'C' programs (By using some mathematical & logical operation)
4. Chemical kinetics in Food processing, Developing and executing simple 'C' programs (By using Control statements: if, if-else, multiple if-else)
5. Use of Word Processing software (MS- Power Point) for creating reports and presentation, Developing and executing simple 'C' programs (By using Control statements: nested if's, conditional operator and switch statements)
6. Familization with the application of computer in food industries, Developing and executing simple 'C' programs (By using loops: while, do- while loops)
7. Milk plant, dairy units, fruit and vegetable processing unit familization with software related to food industries, Developing and executing simple 'C' programs (By using loops: for loop)

8. Ergonomics application in the Food industries, Developing and executing simple 'C' programs (By using arrays: single (or) one dimensional arrays)
9. Developing and executing simple 'C' programs (By using arrays: two dimensional arrays)
10. Developing and executing simple 'C' programs (By using four types of Functions)
11. Developing and executing simple 'C' programs (By using a string functions: strlen(), strrev(), strcpy ())
12. Developing and executing simple 'C' programs (By using a string functions: strcat(), strlwr(),strupr())
13. Developing and executing simple 'C' programs (By using pointers)
14. Developing and executing simple 'C' programs (By using structures, unions)
15. Developing and executing 'C' programs (By using Linked lists & operations: Insertion & Deletion of a nodes to and from a linked lists respectively)
16. Developing and executing 'C' programs (By using Stack & operations : PUSH & POP By using Queues & operations: ENQUEUE & DEQUEUE)

References

Yeswanth Kanethkar, *Let us 'C'*

Balaguruswamy E., *Computer Programming in 'C'*

Mark Allen Waive , *Data Structures*

M. S Excel 2000, *Microsoft Corporation*

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Verton M.V. , *Computer concepts for Agri Business* – AVI Pub. Corp., West Port, USA.

DEPARTMENT OF FOOD TRADE AND BUSINESS MANAGEMENT

1. Course No : FTBM - 352
2. Title : **Food Laws and Regulations**
3. Credit Hours : 3 (2+1)
4. Objectives : To impart knowledge to the students on various acts, rules, regulations, standards, orders and laws related to food articles governing their manufacture, import, export, storage, distribution and sale

5. Specific Objectives

a) Theory

By the end of the course, the students will be able to

- i. know and understand the various national and international standards for different food articles in detail
- ii. understand the food regulatory mechanism in our country

b) Practical

By the end of the course, the students will be able to

- i. examine cereals, pulses, jams, jellies, marmalades, squashes, ketchup/sauce for their compliance with BIS and FPO specifications respectively
- ii. examine Ghee, other dairy and Milk products for their compliance with AGMARK and BIS standards
- iii. examine various spices available in the market for compliance with AGMARK and BIS standards
- iv. understand the analytical procedures involved along with field knowledge in examining the food articles for different standards by visiting BIS, AGMARK, QC laboratory and various food processing industry

Theory Lecture Outlines

1. Introduction - What is the need for food/standards and their enforcement
2. Various types of laws- Mandatory/Regulatory and Voluntary/Optional - Introduction to various food laws (Mandatory) - Food Safety and Standards Act, 2006 (FSSA), Edible Oils Packaging (Regulation) Order, 1998, Environment (Protection) Act, 1986, Fruit Products Order, 1955 (FPO), Meat Food Products Order, 1973 (MFPO), Milk and Milk Product Order, 1992

(MMPO), Solvent Extracted Oil, De-oiled Meal and Edible Flour (Control) Order, 1967, Standards of Weights and Measures Act, 1976, The Essential Commodities Act, 1955, The Export (Quality Control and Inspection) Act, 1963, The Insecticides Act, 1968, Vegetables Oil Products(Control) Order, 1998, Prevention of Food Adulteration Act & Rules (PFA Act), 1954

3. Introduction to various food laws (Voluntary) - Agmark Standards (AGMARK), Codex Alimentarius Standards, BIS Standards and Specifications, Consumer Protection Act, 1986
4. Food Safety and Standards Act, 2006 (FSSA) - Need, Scope and Definitions (Chapter I of FSSA, 2006)
5. Establishment of Food Safety and Standards Authority of India (FSSAI) (II), Composition of FSSAI and qualifications for appointment of its Chairperson & other Members
6. Functions of the chairperson and other members of FSSAI
7. Establishment and Functions of Central Advisory Committee, Scientific Panels, Scientific Committees. Duties and functions of Food Authority
8. General principles to be followed in the administration of FSSA (III). General provisions as to articles of food in the FSSA (IV). Special responsibility as to safety (VI). Analysis of food (VIII). Offences and penalties (IX)
9. Enforcement of FSSA (VII). Food Safety Officer (FSO)/ Food Inspector (Called so by PFA Act) - Powers, Duties and functions of FSO
10. Prevention of Food Adulteration Act & Rules (PFA Act), 1954. Definition. Object of the act. Central committee for food standards
11. Analysis of Food - Public Analysts & Food Inspectors. Powers of the food Inspectors. Procedures to be followed by the Food Inspectors. Report of public analyst. (PFA Act 1954 and Part IV of PFA Rules, 1955) Sealing, fastening and dispatch of samples
12. Powers of Court (Section 14 to 25 of PFA Act, 1954)
13. Consumer Protection Act, 1986 and Consumer Protection Rules, 1987. - Need, Scope, Functions and Enforcement
14. Environment (Protection) Act, 1986. - Need, Scope, Functions and Enforcement
15. The Insecticides Act, 1968. - Need, Scope, Functions and Enforcement
16. The Export (Quality Control and Inspection) Act, 1963. - Need, Scope, Functions and Enforcement
17. Fruit Products Order, 1955 (FPO). - Need, Scope, Functions and Enforcement

18. Milk and Milk Product Order, 1992 (MMPO).- Need, Scope, Functions & Enforcement
19. The Plants, Fruits and Seeds (Regulation of Imports in India) Order, 1989. - Need, Scope, Functions and Enforcement
20. Edible Oils Packaging (Regulation) Order, 1998. - Need, Scope, Functions & Enforcement
21. Meat Food Products Order, 1973 (MFPO).- Need, Scope, Functions & Enforcement
22. Standards of Weights and Measures Act, 1976. - Need, Scope, Functions & Enforcement
23. The Essential Commodities Act, 1955. - Need, Scope, Functions & Enforcement
24. Optional food standards. Their scope, Need - Procedure to obtain that standard (ISO 9001, 14000 etc.)
25. AGMARK
26. Bureau of Indian Standards (BIS)
27. Codex Alimentarius
28. Scope of Codex Alimentarius and Codex Standards
29. Codex standards for Cereals & Pulses
30. Codex standards for Fruits and Vegetables
31. Codex standards for Meat and Poultry products
32. Recommended International Code of hygiene for various food products

Practical Class Outlines

1. Examination of cereals & pulses from one of godowns and market shops in relation to FPO and BIS specifications
2. Examination of ghee for various standards of AGMARK & BIS standards
3. Examination of spices for AGMARK and BIS standards.
4. Examination of milk and milk products for BIS standards
5. Examination of milk product order- standards
6. Examination of fruit products such as jams, jellies, marmalades for FPO specification
7. Examination of fruit products such as jams, jellies, marmalades for FPO specification
8. Examination of two brands of squash for FPO specification
9. Examination of two brands of squash for FPO specification
10. Examination of two brands of ketchup/ sauce for FPO specification

11. Examination of two brands of ketchup/ sauce for FPO specification
12. Visit to BIS laboratory
13. Visit to AGMARK laboratory
14. Visit to quality control laboratory
15. Visit to food processing laboratory - I
16. Visit to food processing laboratory - II

Reference books

Visit <http://www.cfst-angrau.co.cc> OR <http://www.cfst-bapatla.blogspot.com> for all Act, Order, Rules and other material.

Patricia and A curtis *An operational Text Book, Guide to Food Laws and Regulations.*

Ranganna S. *Hand book of Analysis and Quality Control for Fruit and Vegetable Products .*

Srilakshmi B. *Food Science .*

Avanthi Sharma *A text book of Food Science and Technology.*

Sumati R Mudambi, Shalini M Rao and Rajagopal M.V. - *Food Science.*

Norman N Potter and Joseph H Hotchkiss - *Food science.*

Dev Raj, Rakesh Sharma and V.K. Joshi *Quality for Value Addition in Food Processing.*

DEPARTMENT OF ENGLISH

1. Course No. : ENGL - 101
2. Title : **Comprehension and Development of Communication Skills**
3. Credit hours : 2(1+1)
4. General Objectives : To develop the comprehension and communication skills of I year B.Tech (Food Technology) students in English
5. Specific Objectives
 - a) Theory

By the end of the course the students will be able to

- i. understand the basic concepts of comprehension
- ii. understand the fundamentals of grammar
- iii. enhance their vocabulary
- iv. improve their skills in written communication

b) Practical

By the end of the course, the students will be able to

- i. have a clear concept of communication skills in English by using AV aids in spoken English.
- ii. improve their reading skills.
- iii. present the reports orally and participate in debates and group discussions.

A) Theory Lecture Outlines

1. War Minus Shooting, Reading Comprehension
2. War Minus Shooting, Reading comprehension
3. Synonyms, Antonyms
4. Words often confused
5. A Dilemma - A Layman Looks at Science Reading comprehension
6. A Dilemma - A layman Looks at Science Reading comprehension
7. Homonyms

8. Homophones
9. You and Your English, Reading comprehension
10. You and Your English, Reading comprehension
11. Functional Grammar – Agreement of verb with subject
12. Functional Grammar – Agreement of verb with subject
13. Business correspondence
14. Style in Report Writing
15. Precise Writing
16. Interviews

B) Practical Class Outlines

1. Listening to short talks and lectures
2. Spoken English, stress and intonation
3. Seminars and Conferences
4. Seminars and Conferences
5. Oral Presentation by students
6. Evaluation of Oral Presentation
7. Types of Communication face to face
8. Types of Communication – telephonic conversation
9. Reading skills
10. Meetings, purpose, procedure, participation
11. Meetings, chairmanship, physical arrangements etc.
12. Presentation of reports by using power point and LCD
13. Interviews
14. Interviews
15. Group discussion
16. Review/Feed back

References

- N. Krishnaswamy and T. Sriraman 1995, *Current English for Colleges*. Macmillan India Ltd., Chennai.
- Sharma RC and Krishna Mohan 1978, *Business Correspondence and Report Writing*. Tata McGraw Hill Publishing company, New Delhi.
- Naraynaswamy VR, 1979, *Strengthen your writing*. Orient Longman, New Delhi.
- Balasubramanian T, 1989, *A Textbook of Phonetics for Indian Students*. Balasubramanian T, 1989, Orient Longman, New Delhi.
- Krishna Mohan and Meera Benerjee 1990, *Developing Communication Skills*. Macmillan Indian Ltd., New Delhi.
- Balasubramanyam M 1985, *Business Communication* – Vani Educational Books, New Delhi.
- Jean B. Naterop and Roo Revell 1997, *Telephoning in English* –Cambridge University Press, Cambridge.

DEPARTMENT OF STATISTICS AND COMPUTER APPLICATION

1. Course No. : STAM - 104
2. Title : **Engineering Mathematics**
3. Credit hours : 3 (2+1)
4. General Objectives : To increase the ability in understanding and analyzing the reasons about the mathematical concepts related matrices. Differential equations, etc. also they are able to construct different mathematical models related to food science

5. Specific Objectives

a) Theory

By the end of the course,

- i. by studying D.E.s enables the student to describe the rate of change of any function such as temperature, velocity, population and volume etc.
- ii. it enhances the awareness of the existence of mathematical objects such as matrices which will not be suitable to the same rules of operations in the real number systems

b) Practical

By the end of the course student can construct different mathematical models in food science and some of the fields. Further they can study and compare the existing results with real life situations

- i. areas and volumes enclosed by plane curves and surfaces
- ii. maximum and minimum of a function in a closed interval
- iii. to examine the system of linear simultaneous equations using matrices
- iv. the radius of curvature
- v. directional derivatives and angle between the surfaces with the help of vector calculus

A) Theory Lecture Outlines

1. Definition of matrix - Examples - Types of matrices and examples
2. Definition of rank of matrices and problems
3. Solutions of homogeneous in matrices.
4. Solutions of non homogeneous in matrices

5. Given matrix reduce in to normal form
6. Given matrix reduce in to PAQ form
7. Definition of inverse matrix and problems
8. Given matrix reduce in to echelon form
9. Problems of inverse of matrix by Gauss Jordan method
10. Introduction to vector calculus- definition of limits and continuity
11. Definition of gradient and problems
12. Definition of divergence and problems
13. Definition of curl and problems
14. Definition of curvature and radius of curvature and problems
15. Introduction to differentiation-formulas and problems
16. Problems on maxima of several variables
17. Problems on minima of several variables
18. Introduction to partial differentiation and formulas
19. Problems on partial differentiation
20. Introduction to integration and formulas
21. Problems on double integration
22. Definition of differential equation and problems
23. Formation of ordinary differential equations
24. Solutions of first order first degree differential equations
25. Solutions of variables separable-homogeneous differential equations
26. Solutions of non-homogeneous differential equations
27. Solutions of clairuts differential equations
28. Introduction to second order differential equations with constant coefficients
29. Problems on second order differential equations with constant coefficients
30. Solutions of exact differential equations
31. Introduction to second order differential equations with variable coefficients

32. Problems on second order differential equations with variable coefficients

B) Practical Class Outlines

1. Problems on rank of a matrix and Echelon form
2. Rank of a matrix-reduction to normal form
3. Problems on linear dependence and linear independence
4. Problems on inverse of a matrix by gauss Jordan method
5. Problems on limits and continuity of limits
6. Problems on gradient, divergents and curl of vector functions
7. Problems on radius of curvature
8. Problems on partial differential equations and total differentiation
9. Examples on maxima and minima of functions of several variables by legranges multipliers
10. Problems on applications of integrations
11. Problems on formation of ordinary differential equations
12. Problems on variables separable and homogeneous and non homogeneous Equations
13. Problems on exact differential equations
14. Problems on first order and of higher degree and clairuts form
15. Problems on second order linear differential equations with constant coefficients
16. Problems on homogeneous linear equations with variable coefficients

References

Santhi Narayan (1993), *A Text Book of Vector Calculus* - S Chand and Co Ltd., New Delhi

Santhi Narayan (1993), *A Text Book of Matrices* - S Chand and Co Ltd., New Delhi

Santhi Narayan (1993), *Differential Calculus* - S Chand and Co Ltd., New Delhi

Santhi Narayan (1993), *Integral Calculus* - S Chand and Co Ltd., New Delhi

DEPARTMENT OF STATISTICS AND COMPUTER APPLICATION

1. Course No. : STAM - 105
2. Title : **Statistics**
3. Credit hours : 3 (2+1)
4. General Objective : To impart knowledge to the students on basic knowledge of Statistics and its applications in Food Science and Technology
5. Specific Objectives
 - a) Theory

By the end of the course, the students will be able to

- i. acquaint with applications of concepts and statistical techniques in Food Science
- b) Practical

By the end of the practical exercises, the students will be able to

- i. acquaint with practical applications of statistical techniques in Food Science
- ii. make self sufficient and to draw valid conclusion of statistical techniques

A) Theory Lecture Outlines

1. Introduction- Various Definitions of Statistics, Singular and plural reference of Statistics, a comprehensive definition of Statistics, Importance of Statistics in agriculture, limitations of statistics
2. Frequency Distribution - exclusive and inclusive methods, discrete and continuous variables
3. Central tendency - Definition, measures of Central tendency, list of all the different measures and study of Arithmetic Mean in detail (including merits and average) Arithmetic Mean for ungrouped and grouped data
4. Measures of Dispersion - meaning of measures of Dispersion, Standard Deviation for ungrouped and grouped data
5. Coefficient of Variation (C.V), Standard Error (S.E.) and difference between S.D. and S.E.
6. Normal Curve and its properties, identification of normality through data i.e. , $\mu \pm \sigma$ criterion. Etc., expression for frequency function of normal distribution

7. Testing of Hypothesis - Concept, Null hypothesis, Type 1 and Type II Errors, Level of Significance, critical region, general setup of testing
8. SND test for one sample when σ known and unknown
9. SND test for two sample when σ known and unknown
10. Students t-test for one and two samples
11. Paired t- test and F-test
12. Chi-Square test for 2×2 and $m \times n$ contingency Table, Yate's Correction for continuity
13. Correlation – Scatter diagram, positive and negative correlation
14. Correlation Coefficient “r” and its testing
15. Regression – Fitting of linear regression equation of Y on X and X on Y and the inter relation-ship with “r” and testing of regression coefficients
16. Analysis of Variance (ANOVA), Definition and assumptions, ANOVA with One-way Classification
17. ANOVA with Two way Classification
18. Need for experimental designs and planning of an experiment
19. Principles and Planning of experimental designs
20. Uniformity Trials- its use in determining optimum plot size, shape and size of Blocks
21. Uniformity Trials – Maximum Curvature method, FF Smith Methods.
22. Completely Randomized Design (CRD) – layout and analysis with equal and unequal repetitions, advantages and disadvantages
23. Randomized Block Design (RBD) – layout and analysis, advantages and disadvantages
24. Latin-Square Design(LSD) - layout and analysis, advantages and disadvantages
25. Missing Plot technique – in RBD with one missing value
26. Missing Plot technique – in LSD with one missing value
27. Factorial Experiments – Introduction , 2^2 Factorial Experiments using Yate's method
28. Factorial Experiments – 2^3 Factorial Experiments using Yate's method
29. Mixed factorial Experiments
30. Introduction to Sampling, Sampling Vs Census, Purposive and Random Sampling
31. Simple Random Sampling, method of selection, estimates of Population Mean and Total and the estimates of their variances and confidence limits

32. Stratified Random Sampling with random allocation, estimates of Population Mean and Total and the estimates of their variances and Confidence Limits

B) Practical Classes Outlines

1. Preparing frequency distribution for ungrouped data by using inclusive and exclusive methods
2. Computation of A.M. for grouped and un-grouped data by direct and deviation methods
3. S.D and CV% for grouped and ungrouped data
4. SND test for one Sample, two sample with known and unknown conditions
5. Student's t-test for single sample, two sample and paired t- test
6. F-test (Test for homogeneity of variances)
7. Chi-square test and Yates Correction in Chi-square test
8. Correlation Coefficient and its testing
9. Fitting of Linear Regression and its testing
10. Analysis of CRD with equal and unequal repetitions
11. Analysis of RBD
12. Analysis of LSD.
13. Missing plot Technique in RBD and LSD.
14. Analysis of Factorial experiments using Yates' method
15. Simple Random Sampling
16. Stratified Random Sampling with random allocation

References

- Nageswara Rao, G 2007, Statistics for Agricultural Sciences, B S Publications, Hyderabad
- Rangaswamy, R 1995, A Text Book of Agricultural Statistics, New Age International (P) Limited, Hyderabad

DEPARTMENT OF STATISTICS AND COMPUTER APPLICATION

1. Course No. : STAM - 204
2. Title : Introduction to Computer Applications
3. Credit hours : 2 (1+1)
4. General Objectives : To impart knowledge to the students on basic concepts and terminology of computers and its applications.
5. Specific Objectives
 - a) Theory

By the end of the course, the students will be able to

- i. acquaint the concepts of computer and its applications and also the professional way of using MS Office package.

- b) Practical

By the end of the practical exercises, the students will be able to

- i. practice DOS and WINDOWS Operating systems and also the modules of MS Office package i.e word, Excel, Power point and Access in a professional way.

A) Theory Lecture Outlines

1. Introduction to Computers, Anatomy of Computers, Input and Output devices
2. Units of Memory, Hardware, Software, Personal Computers, Types of Processors
3. Booting of Computers, Warm and Cold Booting, Computer Viruses, Worms and Vaccines
4. Operating System - DOS and WINDOWS
5. Some fundamental DOS commands, Format, DIR, Copy, Path, Label, Vol, MD, CD, Type and RD
6. WINDOWS : GUI, Desktop and its elements, Windows Explorer, working with files and folders : Setting time and date, starting and shutting down of Windows
7. Anatomy of a window, Title Bar, Minimum, Maximum, Close buttons, Scroll Bars, Menu and Tool Bars, Applications
8. MS word : Word processing and units of a document, features of word processing packages, creating, editing, formatting and saving a document in MS word

9. MS EXCEL : Electronic Spread sheets, concept, packages, Creating, Editing and saving a spreadsheet with MS Excel
10. Use of in-built Statistical and other functions and writing expressions
11. Use of Data analysis Tools, correlation and Regression, t-test for two samples, creating Graphs
12. Introduction to MS-Power Point, creating slide, adding text, pictures, tables
13. Adding sounds, animation effects, presentation buttons etc.
14. MS Access: Concept of Database, Units of database, creating database
15. Primary key, Relations, Adding link between tables, generating forms and reports
16. Internet: World Wide Web (WWW), Concepts

B) Practical Class Outlines

1. Study of Computer Components
2. Booting of Computer and its Shut down
3. Practice of some fundamental DOS commands, Time, Date, Dir, MD, CD, RD, Copy, Vol, Label
4. Practicing Windows Operating System, Use of Mouse, Title Bar, Minimum, Maximum, and Close Buttons, Scroll Bars, Menus and Tool Bars
5. Windows Explorer, Creating Folder, Copy and Paste functions
6. MS word: Creating a document, Saving and Editing
7. Use of options from Tool bars, Format, Insert and Tools (Spelling & Grammar) Alignment of Paragraphs and Text
8. Creating a Table, Merging of Cells, columns and row width
9. MS-Excel : Creating a spreadsheet, Alignment of rows, columns and cells using format tool bar
10. Entering formula expression through formula tool bar and use of in-built functions Sum, Average, Stdev
11. Data Analysis using inbuilt tool packs, test of significance, Creating Graphs and Saving with & without data
12. Data Analysis using inbuilt tool packs correlations & Regressions

13. MS-Power Point : Creating Slide, adding text, pictures, sounds, presentation buttons, colours etc.
14. MS-Access : Creating a data base, structuring with different types of fields
15. Use of Query facility for accessing the information
16. Creating E-mail IDs, Using Search Engines, etc.

References

- Parmar A Mathur, N., Prasanna, U D and Prasanna VB (2000) *Working with WINDOWS : A Hands on tutorial*, Tata McGraw - Hill Publishing Co., New Delhi.
- Viescas (2005) *Microsoft Office Access - 2003 inside out* , PHI Publishers, New Delhi.
- Vikas Gupta (2002), *Comdex Computer Course Kit*, Dreamtech Press, New Delhi.
- Winston (2000) *Microsoft Excel Data Analysis and Business Modeling.*, PHI Publishers, New Delhi.
- Donald II Sanders Mc. *Computers Today* - Graw Hill Co., New Delhi
- Verton M.W., *Computer concepts for Agricultural Business* - AVI Publishing Co. West Port USA
- MS DOS* - Published by Microsoft Corporation
- MS Office* - Published by Microsoft Corporation

DEPARTMENT OF PLANT PHYSIOLOGY

1. Course No. : BIRM - 101
2. Title : **Environmental Science**
3. Credit hours : 2 (1+1)
4. General Objectives : To impart knowledge to the students on different Environmental concerns and to create a pro-environmental attitude.
5. Specific Objectives
 - a) Theory

By the end of the course, the students will be able to

- i. get knowledge on the importance of environmental studies
- ii. understand about the natural resources and their importance
- iii. acquaint with different types of pollution and their control measures and also on social issues and the environment

b) Practical

By the end of the course, the students will be able to

- i. gain analytical skills in assessing the quality of water, air and soil
- ii. know about the physiological changes in plants with environment

A) Theory Lecture Outlines

1. Introduction - definition, Importance, need for public awareness, Institutions in Environment, People in Environment
2. Ecosystem - Definition Concept of Ecosystem, Components of an Ecosystem, Energy flow-Food chains, Food webs and Ecological Pyramids
3. Ecosystem (contd...) - types of Ecosystems - Forest, Grassland, Desert, Aquatic - Characteristic features, structure and functions
4. Natural Resources - Renewable and Non renewable Resources, Forest Resource - functions of Forests, Causes and consequences of deforestation, Forest Conservation Act, Wildlife Protection Act
5. Natural Resources (contd...) Water resources - Sources, use and over utilization of surface and ground water. Problems associated with water, Sustainable water management, Dams-benefits and problems

6. Natural Resources (contd...) Food resources- World food problems, food security
7. Natural Resources (contd...) Energy Resources Growing energy needs, Non Renewable Energy sources, their impact on Environment
8. Energy Resources (contd...) Renewable energy sources, Advantages, Impact on Environment
9. Natural Resources (contd...) Land Resources -Land use planning, Land degradation and desertification, Role of an individual in conservation of natural resources
10. Environmental pollution-causes, effects and control measures of air pollution, tolerable limits for toxic gases in air
11. Environmental pollution (contd...) causes effects and control measures of water pollution and marine pollution
12. Environmental pollution (contd...) causes, effects and control measures of Soil pollution, tolerable limits for heavy metals in soil
13. Environmental pollution (contd...) causes, effects and control measures of Thermal, Noise pollution and Radioactive pollution
14. Control of Environmental pollution through law-The Air Act, The Water Act
15. Food Processing Industry waste and its management
16. Management of Urban/ Municipal solid waste-Types of solid waste, sources of generation, Processing /disposal/Management technologies

B) Practical Class Outlines

1. Methods for collection and storage of polluted samples
2. Estimation of pH of the polluted water
3. Estimation of EC of polluted water
4. Estimation of total solids in the polluted water
5. Estimation of total dissolved solids (TDS) in the polluted sample
6. Estimation of hardness of polluted water
7. Estimation of dissolved oxygen in the effluent sample
8. Estimation of Biological Oxygen Demand (BOD) in polluted water
9. Estimation of Chemical Oxygen Demand (COD) in polluted water
10. Estimation of nitrates in polluted water

11. Estimation of phosphates in polluted water
12. Estimation of toxic elements
13. Estimation of heavy metals
14. Visit to a polluted environment and studying it
15. Visit to an urban sewage treatment and disposal unit
16. Visit to industrial sewage treatment and disposal unit

References

- Erach Bharucha, 2005. *Text book of Environmental Studies for Undergraduate Courses*, University Grants Commission, Universities Press (India) Pvt., Ltd, Hyderabad.
- Anjaneyulu, 2005. *Introduction to Environmental Science*, BS Publications, Hyderabad.
- Monohara Chary and Jayaram Reddy, 2004. *Principles of Environmental Studies* BS Publishers, Hyderabad.
- Gupta PK, 2004. *Methods in Environmental Analysis : Water, Soil and Air*. Grobios (India) Jodhpur.
- Sharma J P, 2003. *Introduction to Environmental Science*, Lakshmi publications, Guntur.
- Kaul SN and Ashutosh Gautam, 2002. *Water and Waste Water Analysis*, Daya Publishing House, Delhi.

DEPARTMENT OF AGRICULTURAL EXTENSION

1. Course No. : AEXT - 295
2. Title : **Entrepreneurship Development**
3. Credit hours : 2 (1+1)
4. General Objectives : To orient the undergraduate student of B.Tech (Food Technology) to gain knowledge and understanding about the Entrepreneurship Development for moulding them as prospective and dynamic Food Entrepreneurs

5. Specific Objectives

a) Theory

By the end of the semester, the students will be able to

- i. know the concept of Entrepreneur, Entrepreneurship and Entrepreneurship Development in relation to food processing Enterprises
- ii. study the Globalization and the emerging business entrepreneurial environment in Food Industry in India and Abroad

b) Practical

By the end of the semester, the students will be able to

- i. study the role of Entrepreneurship Development Programmes (EDP) in promotion of Food Enterprises
- ii. study the Government policy on Small and Medium Enterprises (SMEs) and Small Scale Industries (SSIs)
- iii. throw light on the concept of a Project in the context of Food Enterprises

A) Theory Lecture Outlines

1. Entrepreneurship Development (ED) : Assessing overall business Environment in Indian Economy
2. Overview of Indian social, political and economic systems and their implications for decision making by Individual Entrepreneurs
3. Globalization and the emerging Business entrepreneurial environment
4. Globalization and the emerging Business entrepreneurial environment
5. Concept of Entrepreneurship; Entrepreneurial and Managerial characteristics

6. Managing an Enterprise; Motivation and Entrepreneurship Development
7. Importance of Planning, Budgeting, Monitoring, Evaluation and Follow-up; Managing competition
8. Entrepreneurship Development Programmes (EDP); SWOT Analysis, Generation, Incubation and Commercialization of Ideas and Innovations
9. Government schemes and Incentives for promotion of Entrepreneurship. Government policy on Small and Medium Enterprises (SMEs)/Small Scale Industries (SSIs)/SEZ & Mega Food
10. Government schemes and Incentives for promotion of Entrepreneurship. Government policy on Small and Medium Enterprises (SMEs)/Small Scale Industries(SSIs)
11. Government schemes and Incentives for promotion of Entrepreneurship. Government policy on Small and Medium Enterprises (SMEs)/Small Scale Industries (SSIs)
12. Export and Import Policies relevant to Agriculture sector
13. Venture capital, Contract Farming and Joint ventures, Public-Private Partnerships.
14. (PPP) Overview of Agri-inputs industry. Characteristics of Indian agricultural processing and Export industry
15. Social responsibility of Business. Morals and Ethics in Enterprise Management
16. Project-Meaning, importance, components and preparation

B) Practical Class Outlines

1. Visit to Public enterprises - I
2. Visit to Public enterprises - II
3. Visit to Private enterprises - I
4. Visit to Private enterprises - II
5. Visit to Food Enterprises/Food Business Centres
6. SWOT analysis of Public enterprises - I
7. SWOT analysis of Public enterprises - II
8. SWOT analysis of Private enterprises - I
9. SWOT analysis of Private enterprises - II
10. Project proposals as an entrepreneur-individual and group - I
11. Project proposals as an entrepreneur-individual and group - II

12. Project proposals as an entrepreneur-individual and group - I
13. Project proposals as an entrepreneur-individual and group - II
14. Presentation of project proposals in the class - I
15. Presentation of project proposals in the class - II
16. Presentation of project proposals in the class - III

References

- Thomas W Zimmer and Norman M Scarborough 1996. *Entrepreneurship*. Prentice Hall, New Jersey, U.S.A.
- Mark. J. Dollinger 1999. *Entrepreneurship Strategies and Resources*. Prentice Hall, Upper Saddle River, New Jersey, U.S.A.
- Khanka S.S. 1999. *Entrepreneurial Development*. S. Chand and Company, New Delhi
- Mohshty Sk. 2007, *Fundamentals of Entrepreneurship*. Prentice Hall, New Delhi.

NON-CREDIT COURSES

1. Course No. : COCA - 100
2. Title : **Physical Education**
3. Credit hours : 1 (0+1)
4. General Objectives : To improve the physical skills and fitness of the students to make them more active, alert and successful

5. Specific Objectives

a) Theory

No theory component

b) Practical

By the end of the practical exercises, students will be able to

- i. develop sound body and mind
- ii. build good character
- iii. promote team work
- iv. present the reports orally and participate in debates and group discussions

A) Theory Lecture Outlines

No theory component

B) Practical Class Outlines

1. Introduction of physical education
2. Posture - exercise for good posture
3. Physical fitness exercise for agility, strength, co-ordination, endurance and speed
4. Rules and regulations of important games
5. Skill development in any one of the games - foot ball, Cricket, volley ball, basket ball, ball badminton, throw ball and tenni koit
6. Participation in any one of the indoor games - Shuttle badminton, chess, caroms and table tennis
7. Rules and regulations of athletic events
8. Participation in any one of the athletic events - broad jump, high jump, javelin throw, discuss throw, shot put, short and long distance running

9. Safety education
10. Movement education
11. Effective ways of doing day to day activities
12. First-Aid Training
13. Coaching in major games and indoor games
14. Asanas and indigenous ways for games for leisure time
15. Leadership development in games or sports
16. Participation and experience in intercollegiate and All India Agricultural Meets

Note : Warming up and conditioning exercises are compulsory before the commencement of each class

References

- Chakravar, P.S. 1989. *Book of Rules of Games and Sports*. YMCA Publishers, Chennai.
- Mangal, S.K. 1980. *Health and Physical Education*. Prakash Brothers Publishers, London.
- Thomas, J.P. 1961. *Organization of Physical Education*, Gnanodaya Press, Chennai.

1. Course No. : **COCA - 200**
2. Title : **N S S**
3. Credit hours : 1 (0+1)
4. General Objectives : To understand the community in which they work; To understand themselves in relation to their community

5. Specific Objectives

a) Theory

No theory component

b) Practical

By the end of the practical exercises, students will be able to

- i. identify the needs and problems of the community and involve them in problem solving process
- ii. develop among themselves a sense of social and civic responsibility
- iii. utilize their knowledge in finding practical solution to individual and Community problems
- iv. develop group living and sharing of responsibilities
- v. acquire leadership qualities
- vi. develop capacity to meet emergencies and natural disasters
- vii. practice national integration and social harmony.

A) Theory Lecture Outlines

No theory component

B) Practical Class Outlines

1. Orientation of students towards national problems
2. Study of the philosophy of N.S.S.
3. NSS programmes and activities
4. Fundamental rights and directive principles of State Policy
5. Socio-economic structure of Indian society
6. Population and five year plans.
7. Functional Literacy - Non-formal education of rural youth

8. Functional Literacy - Non-formal education of rural youth
9. Eradication of social evil and awareness programmes
10. Consumer awareness and highlights of the Consumer Act.
11. Environment enrichment and conservation
12. Environment enrichment and conservation
13. Health, family welfare and nutrition.
14. Health, family welfare and nutrition
15. Right to information act.
16. Special camping programme

References

National Service Scheme Manual (Revised), 2006. Government of India, Ministry of Youth Affairs and Sports, New Delhi.

APPENDIX

REGULATIONS GOVERNING UNDER GRADUATE PROGRAMMES OF THE UNIVERSITY

(as amended upto 21-04-2011)

In exercise of the powers conferred by clause (d) of subsection - 2 of Section 22 of the Acharya N.G. Ranga Agricultural University Act 1963, (Act No.24 of 1963) read with Statute No.21 of the first statutes made by the Government of Andhra Pradesh and statues No. 1 of the additional statutes made by the Board of Management and issued in the proceedings No.750/Stat/6.5 dated 27-7-1965 the Academic Council of the Acharya N.G. Ranga Agricultural University, hereby makes the following regulations (Issued in proc. No. 1415/Acad.I(AI)12002 dt.06-8-2002 and proc. No. 1918/Acad.1 (AI/2001 dt.24-8-2001)

1.0 Short Title

These regulations shall be called 'The ANGRAU Regulations, 2010 governing the under graduate courses of study leading to the award of the degrees of B.Sc.(Ag), C.A. & B.M, B.Tech. (Food Sci.) in the Faculty of Agriculture; B.Tech.(Ag. Engg.) in the Faculty of Agricultural Engineering & Technology and B.Sc.(Hons.) Home Sc. & B.Sc (Hons.) Fashion Technology in the Faculty of Home Science. These regulations shall apply to the students admitted from the academic year 2010-11 and onwards.

2.0 Definitions

2.1 Academic year

The academic year of the University shall ordinarily be from June to April (except in the case of year of admission) and shall consist of two semesters.

***2.2 Semester**

A minimum duration of 110 working days, consisting of 95 instructional days and 15 examination days except during the year of admission.

For a short semester in the year of admission the number of classes should be increased proportionately.

2.3 Credit hour

Each credit hour represents one hour lecture or two hours of laboratory or field practicals each week in a semester. It is also known as semester credit or credit.

2.4 Course

A course is a unit of instruction or segment of subject matter (as specified in the course catalogue) to be covered in a semester. It has a specific number, title and credits.

2.5 Grade point of a course

It is the value obtained by dividing the percentage of marks secured in a course by 10. The grade point is expressed on a 10 point scale upto 1 decimal place.

2.6 Credit point of a course

It is the product of credit hours and grade point obtained by a student in a course.

* Amended vide proc.No.1959/Acad.I/A1/11, dt: 25-03-2011.

2.7 Grade Point Average (GPA)

It is the quotient of the total credit points obtained by a student in various courses at the end of each semester divided by the total credit hours taken by him/her in that semester. The grading is done on a 10 point scale. The GPA is to be corrected up to first decimal place.

2.8 Overall Grade Point Average (OGPA)

It is the quotient of cumulative credit points obtained by a student in all the courses taken by him/her from the beginning of the first semester of the degree course divided by the total credit hours of all the courses which he/she had completed upto the end of a specified semester from the first semester. It determines overall performance of a student in all the courses taken during a period covering more than a semester. The OGPA is to be corrected upto second decimal place.

2.9 Semester final examinations

Semester final examinations for each course are conducted by the University at the end of each semester in the theory portion of the course.

3.0 Admissions

3.1 Admission including selections to the under graduate courses, ordinarily made in the beginning of the first semester of the academic year, shall be in accordance with the regulations laid down from time to time by the University.

3.2 Fee

The fee for application, semester fee, special fee, examination fee and other fee shall be as prescribed by the University from time to time.

4.0 Courses, credits and syllabi

The details of the courses, credits and syllabi of the under graduate courses shall be as prescribed by the Academic Council from time to time.

5.0 Advisory system

The students on their admission shall be divided into convenient batches by the Associate Dean of the college, and each batch is assigned to one of the teachers who are designated as 'Advisor'. Each student immediately after enrolment fills up all the registration cards with the guidance of his/her advisor. Among other things, the advisor shall help the students in planning the programmes of their studies.

The advisor will establish and foster close personal relationship with students assigned to him/her during their entire stay in the college by having periodical meetings either with the entire batch of students or with each individual student as often as is considered necessary in an effort to know their problems, review their study programmes and take such remedial actions as may be necessary in consultation with the teachers concerned and the Associate Dean.

The advisor will maintain a record containing particulars of previous history of the student, courses registered and examinations appeared and grades obtained in each course in each semester as per the format prescribed by the University (Format - 1).

6.0 Registration

6.1 Registration for the first time in the University

Students who have received notification of admission from the University into various faculties will receive, on arrival, guidelines for registration from the Associate Dean of the respective colleges.

A registration and orientation programme will be conducted by the Associate Dean of the college for the benefit of the students joining the University for the first time.

Attendance in respect of fresh students for the first semester shall be reckoned from the date of registration of the student concerned.

6.2 Registration in the subsequent semesters

The following are the steps in registration of students for different courses.

- 6.2 (a) The student in each batch shall have to register for the set of courses offered in toto for that batch and fill in the registration cards in person producing the identity card at the registration center on the day of registration. The students having backlog courses can register the total backlog courses and few fresh courses offered in that semester for that batch and fill in the cards. The Advisor in turn will countersign and send them to the Associate Dean's office. The Associate Dean's office should prepare a list of students who have registered for each course and send them course-wise to the concerned teacher within a week.
- (b) The payment of fee and other arrears due to the college, department, hostel, library etc., shall precede registration.
- (c) Late fee for U.G. students shall be Rs. 10/- for the first three working days starting from the next day of the scheduled date of registration and thereafter Rs. 100/- per day for a further period of seven (7) days.

*Amended vide Proc.No.1700/Acad.I/2003, Dt:25-08-2003

The attendance will however be reckoned from the day the instruction commences as per the academic calendar. However, in respect of RWEPP / intern ship / Experiential Learning Programmes (ELP), the rules as prescribed in RWEPP manual / intern ship guidelines / Experiential Learning Programmes' manual shall be followed.

6.3 Study load for semester

For the purpose of calculation of study load, number of credits registered in a semester includes fresh courses and courses registered for want of attendance. The total study load for a student shall not be more than 23 credit hours per semester.

***7.0 Attendance**

- 7.1 Every student shall ordinarily attend all classes in a course. However, the minimum attendance prescribed in a course is 75%. The attendance shall be reckoned for

*Amended vide Proc.No.352/Acad.I/A1/11, Dt:05-06-2011

theory and practicals separately. A student who fails to put in the minimum attendance either in theory or practical examination and his/her registration, for that course shall be treated as cancelled.

7.1 (a) The minimum attendance requirements can be relaxed upto 10% on medical grounds (i.e., upto 65% for theory and practical separately) only in case of indoor hospitalization.

7.2 (a) If a student admitted to the first year U.G. courses does not register the courses of first semester of that year or having registered does not put in atleast 75% of attendance in all the courses, his/her admission shall stand cancelled, provided that the admission of a student may not be cancelled in exceptional and deserving cases having regard to the facts and merits of the case as provided in clause (b) of this regulation

(b) A student who wishes to seek relaxation of provision in clause (a) of this regulation for good and exceptional reasons may make an application within 7 calendar days from the last day of instruction of first semester to the Associate Dean of the college concerned giving the grounds and the proof thereof due to which he/she could not fulfil the minimum attendance requirement, provided he/she puts in atleast 60% attendance during the first semester of admission. Such application shall be considered by a committee consisting of Associate Dean, a senior Professor or a senior Associate Professor in the colleges where a Professor is not existing, as nominated by the Associate Dean, the Academic advisor of the college, Advisor of the student concerned and the University Medical Officer. If the committee is satisfied that there were exceptional circumstances warranting exercise of discretion to relax the provision in clause (a) of this regulation, the Associate Dean may pass an order allowing the student to continue the studies in relaxation of the provision in clause (a). The student so permitted to continue the studies shall re-register the courses, in which he/she had shortage of attendance, when offered next.

*7.3 When a student has to leave the college after completion of first semester of study, for reasons beyond his/her control, he/she shall obtain prior permission of the Associate Dean for discontinuation within one month from the date of discontinuation. If a student fails to take such permission, he/she shall not be eligible for readmission. The maximum period of break shall not exceed 4 (four) semesters under any circumstances including the semester during which he/she discontinued. A student, permitted to discontinue by the Associate Dean, shall apply to the Associate Dean for readmission, atleast one month before the commencement of the semester in which readmission is sought.

7.4 Where a student leaves the colleges taking a T.C. he/she shall not be eligible for readmission.

* Amended vide proceedings No. 1201/Acad.1/A1/99. Dt. 14-6-99 applicable w.e.f 1999 admitted batch students.

8.0 Evaluation of student, examinations and grades

- 8.1 (a) The evaluation of the student in a course shall be based on his/ her performance in various kinds of examinations, records, class work and other types of exercises
- (b) The detailed course outlines in each course shall be prepared by the concerned teacher(s) in consultation with the University Head of the Department/Head of the Department, which will be made available to the students during the first week of the semester. A schedule of the mid- semester examinations of the academic programme shall be prepared by the Associate Dean and notified to the students at the beginning of each semester
- (c) Answer scripts of mid-semester examinations are evaluated by the teacher shall be shown to the students. The students shall have the option to request the teacher for clarification of any doubts in scoring, provided that such clarification is requested for when the answer scripts are made available to them. This, shall not apply for final examinations.

8.2 Mid-semester examinations

There shall be one mid-semester examination to be conducted by the teacher offering the course after 50% of the working days are over in a semester. The duration for mid-semester examination shall be for one and half hours.

The marks allotted for mid-semester and semester final theory examinations shall be 50 and 100, respectively. Ordinarily no condonation for absence of mid-semester examination shall be given. However, if a student is genuinely prevented from taking examination as in the case of serious illness or accident or any other case, a special re-examination may be arranged by the concerned teacher in consultation with the Head of the department. This repeat examination shall be held within two weeks from the date of examinations so missed, and shall be a common examination for all such students.

Unless a student appears for the mid-semester examination he/she shall not be permitted to appear for the semester final theory and practical examinations in the course concerned.

The regular mid-semester examination and the special re-examination shall be conducted as per the time to be fixed by the Associate Dean.

8.3 (a) Semester final examinations

The semester final examinations shall be held at the end of each semester in each course. The semester final examination in the theory portion shall be of two and half hours duration. It shall be the responsibility of the University to conduct the theory portion of semester final examination. Practical examinations shall be conducted by the respective colleges. The students shall be given two preparation holidays (inclusive of the public holiday) before the commencement of semester final theory examinations.

(b) Answer scripts of semester final theory examination are evaluated through common spot valuation system in selected centres, year of study wise. On the last day of semester final examinations, the Associate Dean shall send all the sealed answer scripts to the selected

center where they are coded, before distribution for valuation. The duration of spot valuation is 6 working days.

Teacher shall be nominated by the Dean of Agriculture for spot valuation. The nominated teachers shall report to the concerned Associate Dean shall submit award list of marks to the Associate Deans after completion of correction of answer scripts allocated to her/him.

8.4 Computation and award of course grades

In the allocation of marks for the course, each credit may be evaluated for 50 marks. Marks allotted for theory and practicals shall be in proportion to the credits for the theory and practicals. The proportion of marks for the semester final common theory examinations and mid-semester examinations shall be 60:40 respectively. Marks for the practical shall be based on continuous evaluation of practical classes and a final practical examination which shall include a viva-voce examination.

The proportion of marks between continuous internal evaluation of practical work and final practical examination shall be of 1:1. In respect of RWE Programme, intern ship and ELP, etc., the criteria for evaluation of students as prescribed in manuals of respective programmes shall be followed.

8.5 Mass absence of students from a class or examination

Absence of students 'enmasse' from a class or examination shall not be condoned. The Associate Dean, in addition, may order suspension of the course, if deemed necessary.

8.6 Unfair means during tests and examinations

The Associate Dean of the college shall be responsible for dealing with all cases of use of unfair means in various examinations.

The phrase, 'Use of Unfair Means' include possession of any information or material by the student, talking to other students, copying from other students or from printed or written material may include 'use of mobiles or any other electronic gadgets', impersonation etc. The invigilator concerned, on finding the use of unfair means by any student may take the answer scripts of the student and the material evidence, if any, and the explanation from the student. The student may also be sent out of the examination hall immediately. The invigilator concerned shall report each case of unfair means direct to the Associate Dean immediately with full details of the incident, answer scripts, the available evidence and explanation of the concerned students, if any. The Associate Dean, on receipt of the report, may give an opportunity to the concerned student to represent his/her case considering all the available evidence, the Associate Dean shall take appropriate action immediately. The penalty shall be as indicated below:

- (a) A student found using unfair means during mid-semester examination shall be deemed to have failed in that course.
- (b) A student found using unfair means during semester final examination shall be deemed to have failed in all the courses, he/she has registered in that semester and/or in such of those courses in which he/she appeared for semester final

examination in that semester. In such cases, the student shall not be permitted to take the remaining examinations, if any, in that semester

- (c) The Associate Dean shall report each case falling under (a) and (b) above immediately, after passing order to the Dean of the concerned faculty.
- (d) For using unfair means of a serious nature such as ignoring the repeated instructions of invigilator, or abusing or threatening or assaulting the invigilator, warranting higher penalties than those indicated in clauses (a) and (b) above, the Associate Dean, besides treating the student as failed in all the courses he/she registered in that semester, may further debar the student for the succeeding semester and the fact informed to the Dean of the faculty. If further or more severe punishments felt necessary, the Associate Dean shall immediately inform the University about the full details of each together with all the material evidence if any, and his/her recommendation. The explanation or representation of the student, if any, may also be sent. The Vice-Chancellor after examining the case, may debar the student for further period or permanently. The decision of the Vice-Chancellor is final.

The parent or the guardian of the concerned student shall be informed of any punishment awarded to the student and the reason therefor.

8.7 Scrutiny of grades

The student may apply to the Registrar within one week after the announcement of the grades for scrutiny of the totalling of marks of the semester final examination or calculation of grade points obtained by him advancing sufficient reasons for such a request. The fee for such scrutiny shall be as prescribed from time to time.

9.0 Academic status and scholastic deficiencies

9.1 (a) A student shall get minimum of 50% marks in both final theory and final practical examinations separately for a pass in the final examination of a course. If a student does not achieve this he/she has to reappear for the final examination in theory/practical or both as the case may be, when next conducted for such course(s).

(b) A student obtaining a grade point of 5.0 shall be considered to have passed the course. A student getting less than 5.0 shall be deemed to have failed in the course and 'F' shall be indicated in the grade report. A student who secured grade point below 5.0 or who secures above 5.0 but secures less than 50% marks in semester final theory/practical examination of the course (or) was marked absent has to appear for either final theory or practical examination or both (as the case may be).

A student may also have the option to write the mid-semester examination of the course in the same semester when he/she next takes the final examination of that particular course.

In the case of final year B.Sc.(Ag), CA & BM, B.Tech. (Food Science), B.Tech.(Ag.Engg.), and B.Sc (Hons.) Home Science students, re-examination shall be conducted within one month from the date of reopening the colleges after the semester vacation i.e. first semester of the succeeding academic year, in not more than three failed courses,

provided the student would complete his/her graduation requirements by passing said three courses.

(c) Whenever a student wants to take re-examination in any course(s) he/she should fill in the particulars in a prescribed application form duly paying the re-exam fee of Rs. 50/- (Rupees fifty only) for each course subject to a maximum of Rs. 100/- (Rupees hundred only) within 40 days from the date of commencement of the subsequent semester.

**** 9.1 (d) Deleted**

9.2*

Promotion to second year A candidate is automatically promoted to second year irrespective of the number of courses as absent/failed courses in the first year.

Promotion to third year A candidate should have passed all the courses of first year and should not have more than 6 courses of second year as backlog courses (failed).

Promotion to fourth year A candidate should have passed all the courses of second year and should not have more than 6 courses of third year as backlog courses (failed).

(Implemented from the academic year 2008-09 onwards)

9.3 Year of standing

The year of standing of a student shall be determined solely on the basis of his completion of certain number of credit hours as prescribed by the Academic Council.

10.0 Graduation requirements

@10.1 The student shall satisfy minimum residential requirements and maximum duration as below

The minimum residential requirement is eight Semesters for U.G. Degree Programmes in the University.

The maximum duration of degree programmes is fourteen semesters (7 academic years).

In case of U.G. Home Science, specialization in any one of the following disciplines is obligatory for all the students admitted from the academic year 2000-2011 onwards. However, based on the recommendation of IV Deans Committee of ICAR, the titles of disciplines are changed. Titles of disciplines from 2000-01 to 2006-07 academic years and changed titles from 2007-08 academic year onwards are as follows:

* Amended vide Proc.No.562/Acad.I/A1/08, Dt.24-03-2008

** Deleted vide Proc.No.336/Acad.I/A1/2011, dt:14-06-2011

@ amended vide Proc.No.2226/Acad.I/A1/2011, dt:25-3-2011 and Memo. No.53/Acad.I/ A1/2011, dt:21-04-2011.

2000-01 to 2006-07	2007-08 onwards
1. Apparel & Textiles (APTX)	Textile & Apparel Designing
2. Extension Education (EXTN)	H.Sc. Extension and Communication Management
3. Food and Nutrition (FDNT)	Foods & Nutrition
4. Human Development and Family Studies (HDFS)	Human Development & Family Studies
5. Resource Management & Consumer Sciences (RMCS)	Family Resource Management

The first two years (first four semesters) of study would consist of common core courses and remaining four semesters are for specialization courses. Option for specialization shall be exercised by the students in order to perform at the time of admission the students shall be allocated to different branches based on their performance. Merit shall be taken into consideration if there is more competition for any single specialization.

10.2 Requirements for Bachelor's Degree

A student undergoing courses of study leading to award of the Bachelor's degree viz., B.Sc.(Ag.) (Bachelor of Science in Agriculture), B.Sc.(CA & BM) (Bachelor of Science in Commercial Agriculture and Business Management), B.Tech. (Ag. Engg.) (Bachelor of Technology in Agril. Engineering), B.Tech. (Food Science) (Bachelor of Technology in Food Science) or B.Sc. (Hons.) Home Science or B.Sc. Fashion Technology in Faculties of Agriculture or Agriculture Engineering & Technology or Home Science as the case may be shall pass courses and complete the minimum number of credit hours prescribed there for by the Academic Council from time to time by obtaining minimum OGPA of 5.00 in the 10 point scale.

A student undergoing instructions in U.G. courses of study leading to the award of Bachelor of Science in Agriculture, Bachelor of Science in Commercial Agriculture and Business Management, Bachelor of Technology in Agril. Engineering, Bachelor of Technology in Food Science and Bachelor of Science (Hons.) in Home Science shall have to complete satisfactorily the Rural Work Experience Programme/internship/Experiential Learning Programme, etc., during the final year of the course as prescribed from time to time.

10.3 Classification of successful candidates

The successful candidates after completion of graduation requirements who secured an OGPA of 5.00 or more in the 10 point scale shall be classified as under:

Pass	5.00 to 5.99
Second Class	6.00 to 7.49
First Class	7.50 to 8.49
First Class with Distinction	8.50 and above

NOTE: Class/division shall not be mentioned in the degree certificate but, classification may be given in the transcript as footnote.

11.0 Student responsibility

All under graduate students studying in various faculties of this University are expected to know the requirements for the award of Bachelor's Degree and general academic requirements and assume full responsibility for meeting them. They are expected to keep constantly in touch with their advisors so that the latter may watch their progress and guide them along right lines. In no case a regulation be waived or exception made simply because a student pleads ignorance of it.

12.0 Transfers

12.1 Transfer of a student from one college to another in the same course shall be at the discretion of the University.

For valid reasons transfers may also be permitted by the Vice-Chancellor on an application by the student through the Associate Dean of the college concerned to the Dean of the faculty.

12.2 Transfer of students from other Universities to this University is not permitted.

13.0 Record of courses

To ensure that requirements for the award of degree have been completed by a student, the University shall keep a record of courses completed by the students. A copy of the same shall be maintained by the Associate Dean of the concerned college.

14.0 Authorities to approve results and issue pass certificates, transcripts etc.

The Vice-Chancellor shall approve the results on the recommendation of the Dean of the faculty and Registrar shall issue the Provisional Pass Certificates, transcripts etc. to the candidates.

15.0 Award of diploma

A diploma under the seal of the University and duly signed by the officers authorised in this behalf shall be presented at a convocation to each candidate who has successfully completed the graduation requirements for the award of degree. Diplomas of the candidates who have successfully completed the graduation requirements for the award of degree and are admitted 'IN ABSENTIA' to a degree at a convocation shall be sent by post. The diploma

shall set for the name of the candidate, father's name, mother's name, degree, month and year of successful completion of the graduation requirements etc.

16.0 Amending or cancellation of result

If the result of a candidate is discovered to be vitiated by error, malpractice, fraud, improper conduct or any other reasons, the Vice-Chancellor shall have the power to amend the result in such a manner as to accord with the true position, and to make such declaration as the Vice-Chancellor may deem necessary in that behalf.

If it is found that the result of a candidate has been vitiated by malpractices, fraud or other improper conduct whereby he has been benefited and that he has in the opinion of the Vice-Chancellor, been a party to or connived at the malpractice, fraud or improper conduct, the Vice-Chancellor shall have the power at any time, notwithstanding the award of the Diploma or a Certificate or Prize or a Scholarship, to amend the result of such candidate and to make such declaration as the Vice-Chancellor may deem necessary in, that behalf, including debarring of the candidate from the University for such a period as may be specified and the cancellation of the result of the candidate in such manner as the Vice-Chancellor may decide.

17. Transitory provision

These regulations shall apply to the students who shall be admitted from the academic year 2010 -11 and onwards.

18. No Regulation made by the Academic Council, governing the under graduate courses of study shall be constructed to limit or abridge the powers of the Academic Council to deal with any case or cases of any student or students of the under graduate courses in such manner as it may appear to it to be just and equitable.

FORMAT -1
(REGULATION 5.0)
ACHARYA N.G. RANGA AGRICULTURAL UNIVERSITY
REGISTRATION & AWARD BOOK

1 . Name of the College :

2. Course of student :

3. Name of the student :

4. I.D.NO :

Inner front page :

Name of the College :

Name of the student in full :

I.D.No. :

Father's Name & Occupation :

Mother's Name :

Permanent Address :

Present Address :

Local Address, if residing outside the Hostel :

Name & Address of guardian, if any :

Name of the Institute last studied :

Particulars of the Advisor

Signature of the Student

Name:

Designation:

Department:

Signature of the Advisor

Subsequent pages (As many pages as No. of semesters allowed to complete graduation requirements + (4) additional pages)

First/Second Semester Academic year 2011-12

Boarder/ Day scholar

Sl. No.	Course No. Registered	Title of the Course	Credit hours	Grade Point	*SA/AB/F
(1)	(2)	(3)	(4)	(5)	(6)

Sl. No.	Course No.s in which re-examination is taken	Credit hours	Grade Point/ AB/F
(1)	(2)	(3)	(4)

GPA during the semester _____

OGPA at the end of the semester _____

*SA = Shortage of Attendance

*AB = Absent

*F = Failed

Signature of the Advisor

Sl.No.	Advisory meeting during the semester (dates on which student attended)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Sl.No.	Discipline & conduct, punishment awarded, prizes won, if any	Other remarks
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
